

FANUC Robot series

SAFETY HANDBOOK

B-80687EN/17

- **Original Instructions**

Thank you very much for purchasing FANUC Robot.

Before using the Robot, be sure to read this manual and understand the content.

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

The products in this manual are controlled based on Japan's "Foreign Exchange and Foreign Trade Law". The export from Japan may be subject to an export license by the government of Japan. Further, re-export to another country may be subject to the license of the government of the country from where the product is re-exported. Furthermore, the product may also be controlled by re-export regulations of the United States government. Should you wish to export or re-export these products, please contact FANUC for advice.

In this manual, we endeavor to include all pertinent matters. There are, however, a very large number of operations that must not or cannot be performed, and if the manual contained them all, it would be enormous in volume. It is, therefore, requested to assume that any operations that are not explicitly described as being possible are "not possible".

PREFACE

This manual explains cautions for safety usage of the FANUC robot.

A robot cannot work alone without the end effector or peripheral equipment. Only after it is combined with the end effector and peripheral equipment and assembled as a system, the robot can demonstrate works. In other words, the robot is one part of a system.

FANUC 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 workplace. 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 system safety for your application and installation can best be determined by system safety professionals.

FANUC therefore, recommends that each customer consult with such professionals in order to provide a safe application.

Additionally, robot system owner, it is your responsibility to arrange for the professional training of the personnel in charge of a robot system to recognize known hazards associated with the robot and use it safely. Because FANUC prepares for the professional training course of the robot, please use it.

It is recognized that the operational characteristics of robots can be significantly different from those of other machines and equipment.

Robots are capable of high energy movements through a large volume beyond the base of robots.

Although robots are substitution for work in a dangerous zone or harmful zone, they may cause work-related accidents. Appropriate safety measures for usage are required when a robot is introduced.

In order to prevent work-related accidents by the robot, as indicators of the steps that an employer should take "Technical Guidance on Safety Standard of Industrial Robot Use", the "Ordinance on Industrial Safety and Health", and safe standards (JIS, ISO, IEC, etc.) are available, these describe the matters taken into consideration during installation and usage. Additionally, as the owner, employer, or user of a robotic system, it is your responsibility to arrange for 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.

This manual provides some tips and guidelines for the robot system safety design based on the above standards.

Before using the FANUC robot, be sure to read this manual to understand the contents.

DEFINITION OF SAFETY NOTATIONS

To ensure the safety of workers and prevent damage to the machine, this manual indicates each precaution on safety with "Warning" or "Caution" according to its severity. Read the contents of each "Warning" and "Caution" before attempting to use the robot.



Symbol	Definitions
 WARNING	Used if hazard resulting in the death or serious injury of the user will be expected to occur if he or she fails to follow the approved procedure.
 CAUTION	Used if a hazard resulting in the minor or moderate injury of the user, or equipment damage may be expected to occur if he or she fails to follow the approved procedure.
NOTE	Used if a supplementary explanation not related to any of WARNING and CAUTION is to be indicated.

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1 SAFETY PRECAUTIONS

This chapter describes the precautions which must be followed to ensure the safe use of the robot. Before using the robot, be sure to read this chapter thoroughly.

For detailed functions of the robot operation, read the relevant operator's manual to understand fully its specification.

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

1.1 PERSONNEL

Personnel can be classified as follows.

Operator:

- Turns the robot controller power on/off
- Starts the robot program from operator panel

Programmer or Teaching operator:

- Operates the robot
- Teaches the robot inside the safeguarded space

Maintenance technician:

- Operates the robot
 - Teaches the robot inside the safety fence
 - Performs maintenance (repair, adjustment, replacement)
-
- The operator is not allowed to work in the safeguarded space.
 - The programmer or teaching operator and maintenance workers are allowed to work in the safeguarded space. Work carried out in the safeguarded space can include transportation, installation, teaching, adjustment, and maintenance.
 - To work inside the safeguarded space, the person must be trained on proper robot operation.

Table 1.1 (a) lists the work outside the safeguarded space. In this table, the symbol “○” means the work is allowed to be carried out by the specified personnel.

Table 1.1 (a) Work Performed Outside the Safeguarded Space

	Operator	Programmer or Teaching operator	Maintenance technician
Turn power ON/OFF to Robot controller	○	○	○
Select operating mode (AUTO, T1, T2)		○	○
Select remote/local mode		○	○
Select robot program with teach pendant		○	○
Select robot program with external device		○	○
Start robot program with operator's panel	○	○	○
Start robot program with teach pendant		○	○
Reset alarm with operator's panel		○	○
Reset alarm with teach pendant		○	○
Set data on teach pendant		○	○
Teaching with teach pendant		○	○
Emergency stop with operator's panel	○	○	○
Emergency stop with teach pendant	○	○	○
Operator's panel maintenance			○
Teach pendant maintenance			○

In the robot operating, programming and maintenance, the operator, programmer, teaching operator and maintenance technician take care of their safety using at least the following safety protectors.

- Use clothes, uniform, overall adequate for the work
- Safety shoes
- Helmet

2 FANUC ROBOT SYSTEM

2.1 PURPOSE OF THE ROBOT

The FANUC Robot Series can be used for the following applications.

- Spot welding
- Arc welding
- Handling
- Deburring
- Assembling
- Sealing
- Painting

TOOL software appropriate for each application is available. Please consult your FANUC sales representative if you want to use the robot for any application other than listed above.

WARNING : Even when you use the robot for the purpose of any of the applications listed above, the robot must NOT be under any of the conditions listed below. Inappropriate usage of robots may cause not only damage to the robot system, but also serious injury or even death of the operator and the people in the premises.

- Used in a flammable atmosphere
- Used in an explosive atmosphere
- Used in a radioactive environment
- Used in water, other liquid, or a high humidity environment
- Used for the purpose of transporting, carrying, riding, or otherwise holding or moving humans or animals
- Used as a ladder (no climbing on the robot)
- Used outdoors
- Used under conditions not in accordance with FANUC recommended installation or use

FANUC is not responsible for any damage or accidents caused by misuse of the robots, such as those mentioned above.

Before using the robot, check the specifications of the robot and all applicable standards, and take all safety measures necessary to prevent hazardous conditions.

2.2 CONFIGURATION OF THE ROBOT SYSTEM

The robot system is configured with the following components.

- Robot
- Robot controller
- Teach pendant
- Safety fence
- Interlocked gate
- Interlocking device
- End effector
- Other peripheral equipment
- Workpieces

Components other than the robot, robot controller, and teach pendant must be prepared by the user according to system configuration.

The FANUC robot has an interface for connection to interlocking devices. Check the specification and design of the interlocking system.

The safety of the following components has been verified by FANUC.

- Robot
- Robot controller and teach pendant

The following component must be prepared by the user according to the robot system configuration.

- Safety fence
- Interlocked gate and interlocking device

However, the safety of the following components is not verified by FANUC due to the wide variety of designs and safety measures.

- End effector
- Workpiece
- Other peripheral equipment

The designer of the robot application system must design the robot system according to safety standards such as EN ISO 10218(ANSI RIA 15.06) and Annex I of Machinery Directive (EU) to ensure sufficient safety.

2.2.1 Robot Training Items

The programmer, teaching operator, and maintenance technicians must be trained to operate the robot and perform maintenance.

The required items are:

- Basic knowledge
- Safety (i.e. laws, regulations, Ordinance on Industrial Safety and Health, and safety measures)
- Jogging,
- Practical training including manual operation and teaching of the robot
- Programming practice, teaching and playback practice
- Practice of automatic operation
- Explanation of configuration and robot function
- Explanation and practice of setting up a coordinate system
- Explanation and practice of programming and program examples
- Explanation of the interface between the robot and peripheral devices
- Explanation and practice of receiving and installing a new robot
- Explanation and practice of checking items when troubleshooting
- Explanation and practice of periodic inspection and approved part replacement
- Explanation and practice of file input and output
- Explanation and practice of mastering
- Explanation and practice of disassembly and reassembly

Some robot training courses for these items are provided. Please contact FANUC at www.fanuc.com.



WARNING

Robot operating personnel such as programmers, teaching operators or maintenance technician must be trained properly according to the laws and regulations in the country or area where the robot is installed and used. Failure to follow appropriate procedures while working inside the safeguarded space or working inside the controller may cause very severe injury or even death of personnel due to hazards such as being pinched by the robot arm.

2.3 RELEVANT STANDARDS

The FANUC Robot Series (for CE marking or NRTL) meets following standards.

[For CE marking : Machinery/Low voltage Directives]

- EN/ISO 10218-1
- EN 60204-1
- EN/ISO 13849-1 (EN 954-1)

[For NRTL]

- UL 1740
- CAN/CSA Z434
- CSA C22.2 No.73

NOTE

For EN ISO 13849-1 (EN954-1), the following safety categories have been applied.

Controller model	Emergency stop	Dual Check Safety (optional functions)			Applied standard
		Position/Speed check	Safe I/O connect	Safety network	
R-30iB Plus, R-30iB Mate Plus, R-30iB Compact Plus, R-30iB Mini Plus, R-30iB, R-30iB Mate, R-30iA, R-30iA Mate	[7DA5/7.50P or later] Cat.4 PL e SIL 3	[7DA5/7.50P or later] Cat.3 PL d SIL 2	[7DA5/7.50P or later] Cat.4 PL e SIL 3		EN/ISO 13849-1:2015
	[7DA1-7DA4/7.20P-7.40P] Cat.4	[7DA1-7DA4/7.20P-7.40P] Cat.3	[7DA1-7DA4/7.20P-7.40P] None		EN 954-1:1996
R-J3iB	Cat. 4 or Cat. 3 (*)	None			
R-J3iB Mate	Cat. 3 (*)	None			
(*) Evaluation was included into total safety assessment by third party. (No independent certificate based on this standard)					

[CE marking : For EMC Directive]

- EN 55011 (Group 1, Class A)
- EN 61000-6-2

For the above standards, FANUC robot systems have been certified by the following third parties.

- CE marking : TÜV Rheinland Japan
- NRTL : TÜV SÜD America

3 ROBOT SYSTEM DESIGN

This chapter describes the requirements for robot system design, that include:

- Equipment Placement
- Power Supply and Protective Earth Connection
- Other Precautions

In addition, the basic requirements for the end effector, workpieces, and peripheral equipment are outlined in Section 3.5.

About the safety fence, safety gate and other protection devices, refer to Sections 4.5 to 4.7.

3.1 GENERAL

The robot system must be designed, constructed, and implemented so that in case of a foreseeable failure of any single component, whether electrical, electronic, mechanical, pneumatic, or hydraulic, safety functions are not affected or when they are, the robot system is left in a safe condition ("Failure to safety").

Under the intended conditions of use, the discomfort, fatigue and psychological stress faced by the operator must be reduced to the minimum possible, taking into account ergonomic principles such as:

- allowing for the variability of the operator's physical dimensions, strength and stamina,
- providing enough space for movements of the parts of the operator's body,
- avoiding a machine-determined work rate,
- avoiding monitoring that requires lengthy concentration,
- adapting the man/machinery interface to the foreseeable characteristics of the operators.

The application of the electrical equipment of the robot system must be accordance with IEC/ EN60204-1 or NFPA70/NFPA79.

3.2 PLACEMENT OF EQUIPMENT

Please make sure the following requirements are all satisfied for each component of a robot system.

- An appropriate safety fence/guard must be placed according to the safety standards. Refer to Sections 4.7 and 4.8 for the requirements of the safety fence/guard and protection devices.
- The risk assessment must determine the additional space required beyond the restricted space (maximum operating area of the robot and end effector) to define the safeguarded space.
- The operator's panel must be located at a safe place:
 - outside the safety fence, and cannot be reached from inside the safety fence,
 - where it can be easily seen, and easily operated by the operator,
 - where the operator can operate it without hesitation or loss of time and without ambiguity, and
 - where no dangerous situation is created by operating it.
- The operating position must be designed and constructed in such a way as to avoid any risk due to exhaust gases and/or lack of oxygen.

- If the robot system is intended to be used in a hazardous environment presenting risks to the health and safety of the operator or if the robot system itself gives rise to a hazardous environment, adequate means must be provided to ensure that the operator has good working conditions and is protected against any foreseeable hazards.
- Where appropriate, the operating position must be fitted with an adequate cabin designed, constructed and/or equipped to fulfill the above requirements. The exit must allow rapid evacuation. Moreover, when applicable, an emergency exit must be provided in a direction which is different from the usual exit.
- A large space must be secured around each component enough for the maintenance and inspection of the robot system.
- The robot system must be designed and constructed in such a way as to allow access in safety to all areas where intervention is necessary during operation, adjustment and maintenance.
- The space inside the safety fence, especially for maintenance and inspection, must be designed to protect the operator from falling off or slipping off the step, and where appropriate, handholds that are fixed relative to the operator and that enable them to maintain their stability should be prepared.
- The robot system must be secured on a stable floor. Especially the robot mechanical unit must be attached to the stable place according to the instructions in the maintenance manual or operator's manual.
- The robot system must be designed to avoid trapping and collision between the moving parts of the robot and other fixed or moving objects.
- The layouts must be designed in such a way that between moving parts of the robot and objects in the environment (e.g. pillars of the structure, ceiling joists, fences), sufficient clearance is available. This rule does not apply to peripheral equipment (such as a conveyer that feeds workpieces) in order to allow it to perform its task.
- When T2 mode is used, the following clearance is required for robot system installation.
 - 0.45m or more from readily accessible areas of buildings, structures, utilities, other machines and equipment not specifically supporting the robot function that may create trapping or a pinch point
 Where this minimum clearance is not provided, additional safeguarding devices is required.
 - Stop robot motion while personnel are within 0.5m of the trapping or pinch hazard

If these actions are not applied, it may cause injury of the users.

- When a limitation of the restricted space, by limiting the range of motion of the primary axes (J1, J2, J3-axes), is required, limiting devices must be provided. They must satisfy one of the following conditions. (except some models such as Genkotsu robot)
 - Mechanical stopper which are capable of stopping the robot at any adjusted position when it is carrying its rated load at maximum velocity.
 - For J2, J3-axis, alternative methods of limiting the range of motion may be provided only if they are designed, constructed, and installed to achieve the same level of safety as the mechanical stoppers.
This may include using the limit switches or DCS according to EN/IEC 60204-1 or NFPA70/NFPA79.
Note that the limiting devices must be correctly adjusted and secured.

- When it is intended that operators will perform manual operations associated with the robot, such as loading and unloading of parts, this must be taken into account in the arrangement of the robot system, either by providing part loading devices so that the operator cannot access the hazardous area, or by providing appropriate safeguards for the manual activity.
- Where appropriate and where the working conditions so permit, work stations constituting an integral part of the robot system must be designed for the installation of seats.
- The operator's seat must enable him or her to maintain a stable position. Furthermore, the seat and its distance from the operator's panel must be capable of being adapted to the operator.
- If the robot system is subject to vibrations, the seat must be designed and constructed in such a way as to reduce the vibrations transmitted to the operator to the lowest level that is reasonably possible. The seat mounting must withstand all stresses to which they can be subjected, where there is no floor beneath the feet of the operator, footrests covered with a slip-resistant material must be provided.
- When preparing a footstep, please consider security for installation and maintenance work in high places according to Fig. 3.2 (a). Please consider an appropriate location for the footstep and safety harness mounting position.

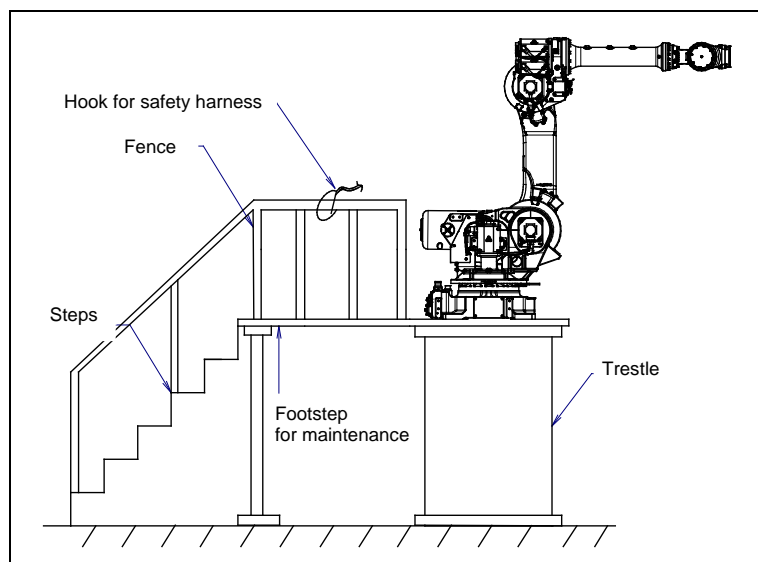


Fig. 3.2 (a) Pedestal for maintenance

- When transporting the robot mechanical unit or controller, follow proper transportation procedures described in the robot-specific operator's or maintenance manual.

**WARNING**

Follow the procedure specified by FANUC when transporting the robot mechanical unit or controller. Otherwise, it may fall over due to the loss of the mechanical stability (balance), resulting in serious injury or death of personnel.

3.3 POWER SUPPLY AND PROTECTIVE EARTH CONNECTION

- Connect the power supply and the protective earth ground according to the maintenance manual.
- Unsafe conditions must be avoided in the event of a power down, power recovery after a power down or supply voltage fluctuations. Unsafe conditions to be avoided are;
 - Dropping a workpiece or any material,
 - Safety equipment not functioning, etc.
- The robot system must have means to isolate its power sources. These means must be located in such a way that no person will be exposed to any hazard, as well as must have a lockout/tagout capability.
- Simultaneously accessible extraneous-conductive-parts in the vicinity of the machine (for example, within 2.5 meters) such as the following must be connected to PE:
 - metallic pipes;
 - fences;
 - ladders;
 - handrails.



WARNING

The robot mechanical unit and controller have to be properly connected by PE (Protective Earth). Without a PE connection, electric shock can occur.

3.4 OTHER PRECAUTIONS

- Shutdown (removal of power) to the robot system or any peripheral equipment must not result in a hazardous condition.
- Evaluate all environmental conditions to ensure compatibility of the robot and the robot system with the anticipated working conditions. These conditions can include explosive mixtures, corrosive gas and liquid, humidity, dust, temperature, electromagnetic interference (EMI), radio frequency interference (RFI), and vibration, etc.
- The operating position where the operator stands must be predetermined.
The operating position must satisfy the following conditions.
 - The operator can easily operate the operator's panel or the teach pendant.
 - The operator can easily make sure that nobody is inside the safety fence.
 - The operator can easily verify the operation of the system.
 - The operator can immediately stop the entire or partial system in the event a malfunction of the system or any dangerous condition.
- The following safety measure must be used if the operator cannot easily verify nobody is inside the safety fence, or as required by the risk-assessment result.
 - A visible/audible warning device (complying EN/ISO/IEC standards or OSHA) is used before the robot starts moving.
 - A measure for the person inside the safety fence to stop the robot system or a measure for the person to evacuate outside the safety fence.
 - The robot system is designed and constructed in such a way that starting it is prevented while someone is in the dangerous zone.
- If necessary, means must be provided to ensure that the robot system can be controlled only from the operating positions located in one or more predetermined zones or locations.

- When the robot system has two or more operating positions, the robot system must be designed in such a way that the use of one of the operating positions precludes the use of the others, except for stop controls and emergency stops.
- When the robot system has two or more operating positions, each position must be provided with all the required control devices so that the operators do not hinder or put each other into a hazardous situation.
- The manual intervention and reset procedure to restart the robot system after an emergency stop must take place outside of the restricted space.
- A warning device must be such that the operator and other persons in dangerous area can easily recognize it.
- For UL standard compliance, “a yellow or amber visual indicator” specified by CL 36.1 of UL 1740 must be installed by the end-user or system manufacturer. The SYSRDY or PROGRUN output signals can be used when installing such a visual indicator.
- The area must be appropriately lighted, especially for maintenance and inspection. The lighting must not create a new dangerous situation (e.g. dazzled).
- It is recommended that adjustment, greasing or oiling, and other maintenance work can be performed from outside the dangerous area while the system is stopping. If it is not feasible, a method to perform these operations safely must be established.
- If the robot and the peripheral equipment synchronously move in the robot system, an appropriate measure must be provided to avoid hazardous condition by stopping the entire system in the event any of the equipment stops due to malfunction.
- For robot systems that can be operated from a remote location (e.g. over a communications network), a means must be provided (e.g. a key operated switch) to ensure that no commands can initiate hazardous conditions from the remote location when in local control.
- It is recognized that, for certain phases of the robot system life (e.g. commissioning, process changeover, cleaning, and maintenance), it may not be possible to design completely adequate safeguards to protect against every hazard or it may be required for safeguards to be suspended. Under these conditions, appropriate safe working procedures must be used.
- A robot system manufacturer must provide an operation manual according to EN/ISO 10218 or other standards.
- The requirements in safety standards (ISO, IEC, JIS, etc.) and the "Ordinance on Industrial Safety and Health" must be considered when a robot application system is designed.
- Suitable ambient lighting have to be provided near the robot.
- Consideration whether (provision of) acoustic and/or visual warning signal is necessary or not should be included in final risk-assessment of robot system.

**CAUTION**

Operation inside of the safety fence (teaching, maintenance, etc.) without suitable ambient lighting can cause hazards of collision (with some obstacles inside of the safety fence) or slipping/falling down of personnel, resulting in injury of personnel.

3.5 END EFFECTOR, WORKPIECE AND PERIPHERAL EQUIPMENT

It is the responsibility of the robot system designer to perform a risk assessment that includes the end effector, workpiece and peripheral equipment.

This section outlines the basic requirement for the risk assessment of these components.

End Effector

- End effectors must be designed and constructed, or safeguarded, so that
 - power failure does not cause release of the load or result in a hazardous condition, and
 - the static and dynamic forces created by the load and the end effector together are within the load capacity and dynamic response of the robot.
- If it is equipped with a tool where it performs operations under different conditions of use, it must be designed and constructed in such a way that selection and adjustment of these conditions can be carried out safely and reliably.

Workpiece

- The material and its shape must not be dangerous and if unsafe, safety measures must be provided.
- If the workpiece is in extreme high or low temperature, safety measures must be provided to avoid personnel from touching or getting too close to it.

Peripheral Equipment (including end effector)

- The material and shape must not be dangerous.
- If any component could break down during operation, it must be placed so that it will not scatter if it breaks down.
- Pipes (for liquid/gas) must be strong enough for its internal / external pressure.
- Pipes must be secured and protected from the external pressure or tension.
- Measures must be provided to avoid a dangerous situation due to sudden movement of the pipe or the high speed flow of material when a pipe is broken.
- If a pneumatic device is used, an air valve which shuts off the air supply to the robot must be installed.
- If a power source other than the electricity (e.g. pneumatic, water, heat) is used in the system, appropriate risk-assessment must be performed, and appropriate safety measures must be provided.
- Be sure to provide safety measures to avoid swapping of components that cause unsafe conditions, by
 - design to avoid mount mistakes,
 - indication of necessary information on the parts.
- Be sure to provide safety measures to avoid poor connections and inferior contacts, by
 - design to avoid poor connections and inferior contacts
 - indication of the information on the connectors, pipes, and cables.
- Be sure to provide safety measures to avoid an unsafe condition by touching an extremely high/low temperature parts (if any).
- Be sure to provide safety measures to avoid fire or explosion through sufficient amount of investigation.
- Vibration and sound noise must be kept to a minimum with consideration for ambient environment.
- Provide peripheral equipment with appropriate grounding (Class A, Class B, Class C, and Class D).]
- When adjusting each peripheral equipment independently, be sure to turn off the power of the robot controller.
- If a laser equipment is used, the following must be considered.
 - Unexpected emission of laser light must be avoided
 - Direct/indirect emission of light must give no harm to the health
 - Laser light must give no harm to health during maintenance / adjustment.

4 SAFETY DEVICES

4.1 STOP TYPE OF ROBOT (R-30iA, R-30iA Mate)

The following three robot stop types exist:

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

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

The following processing is performed at Power-Off stop.

- An alarm is generated and servo power is turned off.
- The robot operation is stopped immediately.

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

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

Controlled stop (Category 1 following IEC 60204-1)

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

The following processing is performed at Controlled stop.

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

Hold (Category 2 following IEC 60204-1)

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

The following processing is performed at Hold.

- The robot operation is decelerated until it stops.

WARNING

- 1 The stopping distance and time of Controlled stop is longer than those of Power-Off stop. A risk assessment for the whole robot system which takes into consideration the increased stopping distance and stopping time is necessary when Controlled stop is used. Please refer to the robot-specific operator's manual for the stopping distance and time data.
- 2 In a multi-arm system, the longest stopping distance and time of Controlled Stop among each robot is adopted as those for the entire system. Perform a risk assessment for the whole multi-arm robot system which takes into consideration the possibility that the stopping distance and time will increase.
- 3 In the system which has one or more extended axes, the longer stopping distance and time of Controlled Stop among robot and extended axes is adopted as those for the entire system. Perform a risk assessment for the whole robot system that has extended axes which takes into consideration the possibility that the stopping distance and time will increase. Please refer to the extended axis setup procedure in the controller-specific software Operator's manual or the Software Installation Manual when considering the stopping distance and time of the extended axis.
- 4 A Controlled stop delays motor power shutdown for a maximum of 3 seconds. In this case, a risk assessment for the whole robot system is necessary, including the 3 second delay.

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

There are the following 3 Stop patterns.

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

P-Stop: Power-Off stop

C-Stop: Controlled stop

-: Disable

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

Option	R-30iA				R-30iA Mate		
	Standard (Single)	Standard (Dual)	RIA type	CE type	Standard	RIA type	CE type
Standard	B (*)	A	A	A	A (**)	A	A
Stop type set (Stop pattern C) (A05B-2500-J570)	N/A	N/A	C	C	N/A	C	C

(*) R-30iA standard (single) does not have servo disconnect.

(**) R-30iA Mate Standard does not have servo disconnect, and the stop type of SVOFF input is Power-Off stop.

The software version screen displays the robot stop pattern of the controller in the "Stop pattern". Please refer to "Software version" in the controller-specific software operator's manual or the Software Installation manual for details of the software version screen.

"Controlled stop by E-Stop" option

When "Stop type set (Stop pattern C) (A05B-2500-J570) option is specified, the stop type of the following alarms becomes Controlled stop but only in AUTO mode. In T1 or T2 mode, the stop type is Power-Off stop which is the normal operation of the system.

Alarm	Condition
SRVO-001 Operator panel E-stop	Operator panel emergency stop is pressed.
SRVO-002 Teach pendant E-stop	Teach pendant emergency stop is pressed.
SRVO-007 External emergency stops	External emergency stop input (EES1-EES11, EES2-EES21) is open. (R-30iA controller)
SRVO-194 Servo disconnect	Servo disconnect input (SD4-SD41, SD5-SD51) is open. (R-30iA controller)
SRVO-218 Ext.E-stop/Servo Disconnect	External emergency stop input (EES1-EES11, EES2-EES21) is open. (R-30iA Mate controller)
SRVO-408 DCS SSO Ext Emergency Stop	In DCS Safe I/O connect function, SSO[3] is OFF.
SRVO-409 DCS SSO Servo Disconnect	In DCS Safe I/O connect function, SSO[4] is OFF.

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

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

For the R-30iA or R-30iA Mate, this function is available only in CE or RIA type hardware.

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

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



WARNING

The stopping distance and stopping time of Controlled stop are longer than the stopping distance and stopping time of Power-Off stop. Perform a risk assessment for the whole robot system that includes this option which takes into consideration the increased stopping distance and stopping time.

4.2 STOP TYPE OF ROBOT (R-30iB, R-30iB Mate)

There are following four types of Stopping Robot.

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

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

“**Power-Off stop**” performs the following processing.

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

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

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

Controlled stop (Category 1 following IEC 60204-1)

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

“**Controlled stop**” performs the following processing.

- The alarm “**SRVO-199 Controlled stop**” occurs along with a decelerated stop.
- An alarm is generated and the servo power is turned off.

Smooth stop (Category 1 following IEC 60204-1)

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

“**Smooth stop**” performs the following processing.

- The alarm “**SRVO-289 Smooth Stop**” occurs along with a decelerated stop.
- An alarm is generated and the servo power is turned off.
- In a Smooth stop, the robot decelerates until it stops with the deceleration time shorter than Controlled stop.

Hold (Category 2 following IEC 60204-1)

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

“**Hold**” performs the following processing.

- The robot operation is decelerated until it stops.

⚠ WARNING

- 1 The stopping distance and time of Controlled stop and Smooth stop are longer than those of Power-Off stop. A risk assessment for the whole robot system which takes into consideration the increased stopping distance and stopping time is necessary when Controlled stop or Smooth Stop is used. Please refer to the robot-specific operator's manual for the stopping distance and time data.
- 2 In a multi-arm system, the longest stopping distance and time of Controlled Stop or Smooth Stop among each robot is adopted as those for the entire system. A risk assessment for the whole multi-arm robot system which takes into consideration the possibility that the stopping distance and time will increase is necessary.
- 3 In the system which has one or more extended axes, the longer stopping distance and time of Controlled Stop or Smooth Stop among robot and extended axes is adopted as those for the entire system. Perform a risk assessment for the whole robot system that has extended axes which takes into consideration the possibility that the stopping distance and time will increase. Please refer to the extended axis setup procedure of the controller-specific software operator's manual or the Software Installation Manual when considering the stopping distance and time of the extended axis.
- 4 When a Smooth stop occurs during deceleration by Controlled stop, the stop type of robot is changed to Power-Off Stop.
When Smooth stop occurs during deceleration by Hold, the stop type of robot is changed to Power-Off Stop.
- 5 Controlled stop or Smooth Stop delays motor power shutdown for a maximum of 3 seconds. In this case, a risk assessment for the whole robot system is necessary, including the 3 second delay.

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

There are the following 3 Stop patterns.

Stop pattern	Mode	Emergency stop button	External Emergency stop	IMSTP input	FENCE open	SVOFF input (*)	Deadman switch
A	AUTO	P-Stop	P-Stop	P-Stop	C-Stop	C-Stop	-
	T1	P-Stop	P-Stop	P-Stop	-	C-Stop	P-Stop
	T2	P-Stop	P-Stop	P-Stop	-	C-Stop	P-Stop
C	AUTO	C-Stop	C-Stop	C-Stop	C-Stop	C-Stop	-
	T1	P-Stop	P-Stop	P-Stop	-	C-Stop	P-Stop
	T2	P-Stop	P-Stop	P-Stop	-	C-Stop	P-Stop
D	AUTO	S-Stop	S-Stop	S-Stop	C-Stop	C-Stop	-
	T1	S-Stop	S-Stop	S-Stop	-	C-Stop	S-Stop
	T2	S-Stop	S-Stop	S-Stop	-	C-Stop	S-Stop

P-Stop: Power-Off stop

C-Stop: Controlled stop

S-Stop: Smooth stop

-: Disable

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

The following table indicates the Stop type of DCS SSO Alarm and NTED input.

Alarm	Stop type
SRVO-406 DCS SSO SVOFF input	Same as SVOFF input.
SRVO-407 DCS SSO Fence Open	Same as Fence Open
SRVO-408 DCS SSO Ext Emergency Stop	Same as Ext Emergency Stop.
SRVO-409 DCS SSO Servo Disconnect	Same as Ext Emergency Stop.
SRVO-410 DCS SSO NTED input	Same as Deadman switch.
SRVO-232 NTED input	Same as Deadman switch.

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

Option	R-30iB/ R-30iB Mate
Standard	A
Controlled stop by E-Stop (A05B-2600-J570)	C
Smooth E-Stop (A05B-2600-J651)	D

The software version screen displays the robot stop pattern in the "Stop pattern". Please refer to "Software version" in the controller-specific operator's manual for details of the software version screen.

"Controlled stop by E-Stop" option

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

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

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

- In a Controlled stop, the robot stops on the program path. This function is effective for a system where the robot can interfere with other devices if it deviates from the program path.
- In a Controlled stop, physical impact is less than Power-Off stop. This function is effective for systems where minimizing the physical impact to the mechanical unit or EOAT (End Of Arm Tool) is important.
- The stopping distance and time of Controlled stop is longer than those of Power-Off stop, depending on the robot model and axis.

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

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



WARNING

The stopping distance and time of Controlled stop are longer than those of Power-Off stop. Perform a risk assessment for the whole robot system that includes this option which takes into consideration the increased stopping distance and stopping time.

"Smooth E-Stop Function" option

When "**Smooth E-Stop Function**" (A05B-2600-J651) option is specified, the stop type of the following alarms becomes Smooth stop in all operation modes (AUTO, T1 and T2 mode).

Alarm	Condition
SRVO-001 Operator panel E-stop	Operator panel emergency stop is pressed.
SRVO-002 Teach pendant E-stop	Teach pendant emergency stop is pressed.
SRVO-003 Deadman switch released	Both deadman switches on Teach pendant are released.
SRVO-007 External emergency stops	External emergency stop input (EES1-EES11, EES2-EES21) is open.
SRVO-037 IMSTP input (Group: %d)	IMSTP input (*IMSTP signal for a peripheral device interface) is OFF.
SRVO-232 NTED input	NTED input (NTED1-NTED11, NTED2-NTED21) is open.
SRVO-408 DCS SSO Ext Emergency Stop	In DCS Safe I/O connect function, SSO[3] is OFF.
SRVO-409 DCS SSO Servo Disconnect	In DCS Safe I/O connect function, SSO[4] is OFF.
SRVO-410 DCS SSO NTED input	In DCS Safe I/O connect function, SSO[5] is OFF.
SRVO-419 DCS PROFIsafe comm. error	PROFINET Safety communication error occurs.

Smooth stop is different from **Power-Off stop** as follows:

- In a Smooth stop, the robot is stopped along the program path. This function is effective for a system where the robot can interfere with other devices if it deviates from the program path.
- In a Smooth stop, physical impact is less than Power-Off stop. This function is effective for systems where minimizing the physical impact to the mechanical unit or EOAT (End Of Arm Tool) is important.
- The stopping distance and time of Smooth stop is longer than those of Power-Off stop, depending on the robot model and axis.

Smooth stop is different from **Controlled stop** as follows:

- The stopping distance and time of Smooth stop is normally shorter than those of Controlled stop, depending on the robot model and axis.

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

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



WARNING

The stopping distance and time of Smooth stop are longer than those of Power-Off stop. Perform a risk assessment for the whole robot system that includes this option which takes into consideration the increased stopping distance and stopping time.

4.3 STOP TYPE OF ROBOT (R-30iB Plus, R-30iB Mate Plus, R-30iB Compact Plus, R-30iB Mini Plus)

There are following three types of Stop Category.

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

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

“Stop Category 0” performs the following processing.

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

Frequent Category 0 Stop of the robot during operation can cause robot mechanical problems.

Avoid system designs that require routine or frequent Category 0 Stop conditions.

Stop Category 1 following IEC 60204-1 (Controlled Stop, Smooth Stop)

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

“Stop Category 1” performs the following processing.

- The alarm "SRVO-199 Controlled stop" or "SRVO-289 Smooth Stop" occurs along with a decelerated stop.
- An alarm is generated and the servo power is turned off.

There are two stop types for Stop Category 1, Controlled Stop and Smooth Stop. In the Smooth stop, the robot decelerates until it stops with a deceleration time shorter than Controlled stop. The stop type of Stop Category 1 is determined depending on the robot model or option configuration.

The models listed below use the Controlled Stop as standard. You can switch to Smooth Stop by specifying the "All Smooth Stop Function" option or the "Smooth Stop Upgrade" option. For details, see the explanation of each option described later.

Models that are not listed in the table below use the Smooth Stop as standard.

Robot models which use Controlled Stop as standard for Stop Category 1					
R-2000iB/170CF	R-1000iA/130F	M-710iC/50	M-1iA/0.5AL	LR Mate 200iD/4S	M-20iA/20M
R-2000iB/200T	R-1000iA/120F-7B	M-710iC/70	M-1iA/0.5S	LR Mate 200iD/7L	M-20iA/35M
R-2000iC/210F	M-900iA/150P	M-710iC/20L	M-1iA/0.5SL	LR Mate 200iD/7C	M-20iA/12L
R-2000iC/165F	M-900iA/200P	M-710iC/50T	M-1iA/1H	LR Mate 200iD/7LC	M-20iA/20MT
R-2000iC/125L	M-900iB/360	M-710iC/70T	M-1iA/1HL	LR Mate 200iD/4SC	M-20iA/35MT
R-2000iC/210R	M-900iB/280L	M-710iC/50E	M-2iA/3S	LR Mate 200iD/7H	M-20iB/25
R-2000iC/165R	M-900iB/280	M-710iC/50H	M-2iA/3SL	LR Mate 200iD/4SH	M-20iB/25C
R-2000iC/270F	M-900iB/700	M-710iC/45M	M-2iA/6H	M-10iA/10M	CR-35iA
R-2000iC/210L	M-900iB/400L	M-710iC/12L	M-2iA/6HL	M-10iA/10MS	CR-7iA
R-2000iC/220U	M-410iB/700	M-710iC/20M	M-2iA/3A	M-10iA/12	CR-7iA/L
R-2000iC/210WE	M-410iB/140H	M-2000iA/900L	M-2iA/3AL	M-10iA/12S	CR-4iA
R-2000iC/100P	M-410iC/185	M-2000iA/1200	M-3iA/6A	M-10iA/7L	
R-1000iA/80F	M-410iC/315	M-2000iA/1700L	M-3iA/6S	M-10iA/8L	
R-1000iA/100F	M-410iC/500	M-2000iA/2300	M-3iA/12H	M-20iA	
R-1000iA/80H	M-710iC/50S	M-1iA/0.5A	LR Mate 200iD	M-20iA/20T	

Stop Category 2 following IEC 60204-1 (Hold)

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

“Stop Category 2” performs the following processing.

- The robot operation is decelerated until it stops.



WARNING

- 1 The stopping distance and time of Stop Category 1 are longer than those of Stop Category 0. A risk assessment for the whole robot system which takes into consideration the increased stopping distance and stopping time is necessary when Stop Category 1 is used. Please refer to the robot-specific operator's manual for the stopping distance and time data.
- 2 In a multi-arm system, the longest stopping distance and time of Stop Category 1 among each robot is adopted as those for the entire system. Perform a risk assessment for the whole multi-arm robot system which takes into consideration the possibility that the stopping distance and time will increase.
- 3 In the system which has one or more extended axes, the longer stopping distance and time of Stop Category 1 among robot and extended axes is adopted as those for the entire system. Perform a risk assessment for the whole robot system that has extended axes which takes into consideration the possibility that the stopping distance and time will increase. Please refer to the extended axis setup procedure of the controller-specific software operator's manual or the Software Installation Manual when considering the stopping distance and time of the extended axis.
- 4 When a Stop Category 1 (Smooth Stop) occurs during deceleration by Stop Category 2, the stop type of robot is changed to Stop Category 0.
- 5 Stop Category 1 delays motor power shutdown for a maximum of 3 seconds. In this case, a risk assessment for the whole robot system is necessary, including the 3 second delay.

When the emergency stop button is pressed or the FENCE is opened, the stop type of robot is Stop Category 0 or Stop Category 1. The configuration of stop type for each situation is called *stop pattern*. The stop pattern is different according to the option configuration.

There are the following 3 Stop patterns.

Stop pattern	Mode	Emergency stop button	External Emergency stop	IMSTP input	FENCE open	SVOFF input (*)	Deadman switch
A	AUTO	Category 0	Category 0	Category 0	Category 1	Category 1	-
	T1	Category 0	Category 0	Category 0	-	Category 1	Category 0
	T2	Category 0	Category 0	Category 0	-	Category 1	Category 0
C	AUTO	Category 1	Category 1	Category 1	Category 1	Category 1	-
	T1	Category 0	Category 0	Category 0	-	Category 1	Category 0
	T2	Category 0	Category 0	Category 0	-	Category 1	Category 0
D	AUTO	Category 1	Category 1	Category 1	Category 1	Category 1	-
	T1	Category 1	Category 1	Category 1	-	Category 1	Category 1
	T2	Category 1	Category 1	Category 1	-	Category 1	Category 1

Category 0: Stop Category 0

Category 1: Stop Category 1

-: Disable

(*) R-30iB Mate Plus, R-30iB Compact Plus and R-30iB Mini Plus do not have SVOFF input.

The following table indicates the Stop type of DCS SSO Alarm and NTED input.

Alarm	Stop type
SRVO-406 DCS SSO SVOFF input	Same as SVOFF input.
SRVO-407 DCS SSO Fence Open	Same as Fence Open
SRVO-408 DCS SSO Ext Emergency Stop	Same as Ext Emergency Stop.
SRVO-409 DCS SSO Servo Disconnect	Same as Ext Emergency Stop.
SRVO-410 DCS SSO NTED input	Same as Deadman switch.
SRVO-232 NTED input	Same as Deadman switch.

The following table indicates the Stop pattern according to the controller type or option configuration.
The case R651 is specified.

Option	R-30iB Plus/ R-30iB Mate Plus / R-30iB Compact Plus/ R-30iB Mini Plus
Standard	C
Old Stop Function (A05B-2670-J680)	A
All Smooth Stop Function (A05B-2670-J651)	D

The case R650 is specified.

Option	R-30iB Plus/ R-30iB Mate Plus / R-30iB Compact Plus/ R-30iB Mini Plus
Standard	A
Stop Category 1 by E-Stop (A05B-2670-J521)	C
All Smooth Stop Function (A05B-2670-J651)	D

The software version screen displays the robot stop pattern in the "Stop pattern". Please refer to "Software version" in the controller-specific operator's manual for details of the software version screen.

"Old Stop Function" option

When "Old Stop Function" (A05B-2670-J680) option is specified, the stop type of the following alarms becomes Stop Category 0 in AUTO mode.

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

Stop Category 0 is different from **Stop Category 1** as follows:

- In Stop Category 0, servo power is turned off, and the robot stops immediately. Servo power is turned off when the robot is moving, and the motion path of the deceleration is uncontrolled.
- The stopping distance and time of Stop Category 0 is shorter than those of Stop Category 1, depending on the robot model and axis.

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

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

"All Smooth Stop Function" option

When "All Smooth Stop Function" (A05B-2670-J651) option is specified, the stop type of the following alarms becomes Stop Category 1 in all operation modes (AUTO, T1 and T2 mode). In this case, the stop type of Stop Category 1 is Smooth Stop.

Alarm	Condition
SRVO-001 Operator panel E-stop	Operator panel emergency stop is pressed.
SRVO-002 Teach pendant E-stop	Teach pendant emergency stop is pressed.
SRVO-003 Deadman switch released	Both deadman switches on Teach pendant are released.
SRVO-007 External emergency stops	External emergency stop input (EES1-EES11, EES2-EES21) is open.
SRVO-037 IMSTP input (Group: %d)	IMSTP input (*IMSTP signal for a peripheral device interface) is ON.
SRVO-232 NTED input	NTED input (NTED1-NTED11, NTED2-NTED21) is open.
SRVO-408 DCS SSO Ext Emergency Stop	In DCS Safe I/O connect function, SSO[3] is OFF.
SRVO-409 DCS SSO Servo Disconnect	In DCS Safe I/O connect function, SSO[4] is OFF.
SRVO-410 DCS SSO Ext Emergency Stop	In DCS Safe I/O connect function, SSO[5] is OFF.
SRVO-419 DCS PROFI-safe comm. error	PROFINET Safety communication error occurs.

Stop Category 1 is different from **Stop Category 0** as follows:

- In Stop Category 1, the robot is stopped along the program path. This function is effective for a system where the robot can interfere with other devices if it deviates from the program path.
- In Stop Category 1, physical impact is less than Stop Category 0. This function is effective for systems where minimizing the physical impact to the mechanical unit or EOAT (End of Arm Tool) is important.
- The stopping distance and time of Stop Category 1 is longer than those of Stop Category 0, depending on the robot model and axis.

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

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



WARNING

The stopping distance and time of Stop Category 1 are longer than those of Stop Category 0. Perform a risk assessment for the whole robot system that includes this option which takes into consideration the increased stopping distance and stopping time.

"Stop Category 1 by E-Stop" option

When "Stop Category 1 by E-Stop" (A05B-2670-J521) option is specified, the stop type of the following alarms become Category 1 Stop but only in AUTO mode. In T1 or T2 mode, the stop type is Category 0 Stop which is the normal operation of the system.

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

Stop Category 1 is different from **Stop Category 0** as follows:

- In Stop Category 1, the robot is stopped along the program path. This function is effective for a system where the robot can interfere with other devices if it deviates from the program path.
- In Stop Category 1, physical impact is less than Stop Category 0. This function is effective for systems where minimizing the physical impact to the mechanical unit or EOAT (End of Arm Tool) is important.
- The stopping distance and time of Stop Category 1 is longer than those of Stop Category 0, depending on the robot model and axis.

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

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

**WARNING**

The stopping distance and time of Stop Category 1 are longer than those of Stop Category 0. Perform a risk assessment for the whole robot system that includes this option which takes into consideration the increased stopping distance and stopping time.

"Smooth Stop Upgrade" option

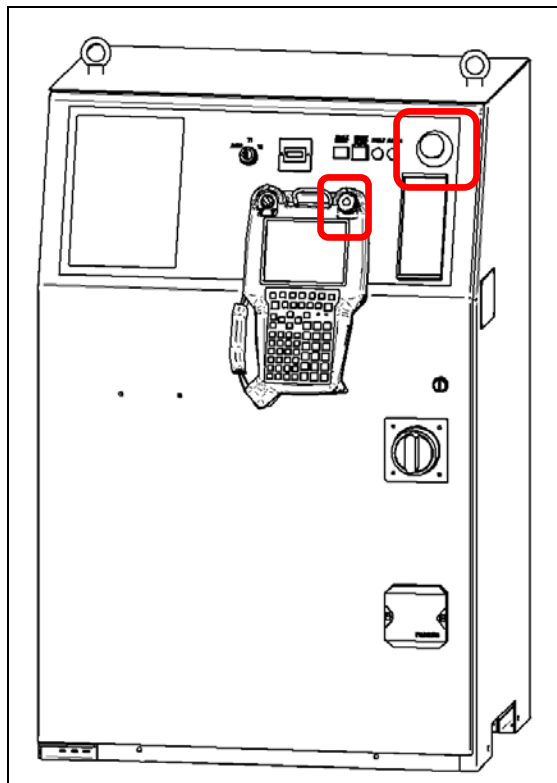
When "Smooth Stop Upgrade" (A05B-2670-J548) option is specified, the stop type of Stop Category 1 switches from Controlled Stop to Smooth Stop.

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

4.4 EMERGENCY STOP

This robot controller has the following emergency stop devices:

- Emergency stop button (located on the operator's panel and teach pendant)
- External emergency stop input signal (a terminal is provided)



When the emergency stop button is pushed, the robot stops immediately (refer to Section 4.1 to 4.3).

The external emergency stop input signal is input from peripheral devices.

The signal terminal is provided inside the robot controller.

Refer to the controller-specific maintenance manual for the actual position of the emergency stop button.

⚠ WARNING

- 1 An operator's panel and teach pendant are an option for some controllers. If your robot does not have an operator's panel or a teach pendant, an emergency stop button is not installed when the robot is shipped. Be sure to connect an external emergency stop input signal to one or more peripheral equipment to perform an emergency stop function.
- 2 If you operate robots without an operator's panel or teach pendant, be sure to install EMERGENCY STOP button(s) within the operator's reach in appropriate location(s) based on the system layout.

4.5 MODE SELECT SWITCH

For R-J3iB controllers or later, the MODE SELECT switch is installed on the operator's panel of the robot controller. (This is an option for some controllers.) You can select one of the operating modes using this switch. The selected operating mode can be locked by removing its key.

Whenever the mode is changed by this switch, the robot stops and displays a message on the teach pendant screen indicating that the operating mode is changed.

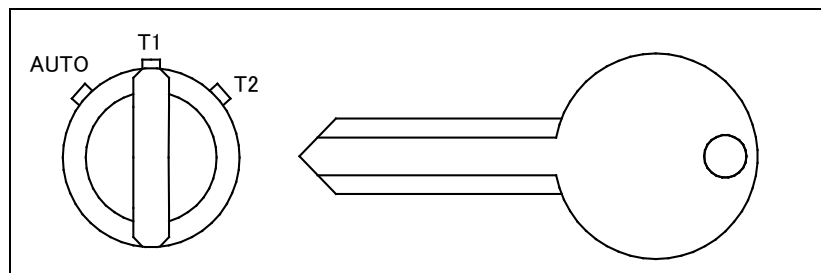


Fig. 4.5 (a) Example of MODE SELECT Switch

4.5.1 Operating Modes

There are two or three operating modes, which are shown below.

AUTO Mode

- The robot program can be started from the operator's panel.
- The robot program can be started from the peripheral device I/O.
- The safety fence is enabled (when the fence is opened, emergency stop occurs). Refer to STOP TYPE OF ROBOT.
- The robot can be operated at the specified maximum speed.

T1 Mode

- The robot program can only be started from the teach pendant.
- The robot cannot be operated at speeds higher than 250mm/s both at the tool center point in the tool coordinate system (zero point of the tool coordinate system) and the center of the flange.
- The safety fence is disabled (even when the fence is opened, the robot does not stop).

T2 Mode (Optional)

- The robot program can only be started from the teach pendant.
- The robot can be operated at the specified maximum speed.
- The safety fence is disabled (even when the fence is opened, the robot does not stop)

The teach pendant, operator panel, and peripheral equipment interface each may send each the robot a start signal. However the validity of each signal changes as shown in the followings table depending on the enable/disable switch of the teach pendant, 3 mode switch on the operator panel and the remote condition on the software.

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

T1, T2 mode: DEADMAN switch is effective.

Refer to the operator's manual of the robot controller for detail.

4.6 ENABLING DEVICE (DEADMAN SWITCH)

When the teach pendant is enabled, robot motion is allowed only while at least one of enabling devices (deadman switches) is gripped. If you release or hard grip switches, the robot stops immediately.

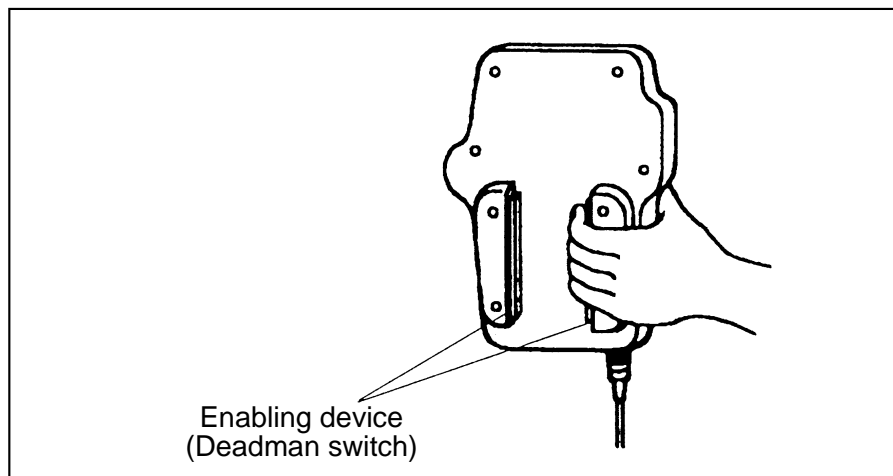


Fig. 4.6 (a) Enabling device (Deadman switch)

Based on the risk assessment by FANUC, the number of operations of the enabling device (deadman switches) should not exceed about 10000 times per year.

4.7 SAFEGUARDS

The safeguards consist of:

- safety fence (fixed guard),
- safety gate (with interlocking devices),
- Safety plug and socket, and
- Other protection devices.

These safety devices must comply with safety standards such as ISO and IEC. They are also installed by the system engineer or integrator.

This section describes the requirements for these safety devices.

Refer to EN/ISO 10218, ANSI/RIA r15.06 and other related local standards for details.



WARNING

Suitable safeguarding must be used for the robot system. Robot operation without safeguarding can cause serious injury or death of personnel due to hazards such as being pinched by the robot arm.

4.7.1 Safety Fence

The requirements for the safety fence are as follows.

- The fence is constructed to withstand foreseeable operational and environmental forces.
- The fence is free of sharp edges and projection and is not itself a hazard.
- The fence prevents access to the safeguarded space except through openings equipped with interlocking devices or presence sensing devices.
- The fence is permanently fixed in position and is removable only with the aid of tools.
- The safety fence is secured by a means that remains attached to the safety fence or to the robot system when it is removed.
- Where possible, the safety fence must be fixed at a given place and cannot be moved.
- The fence must cause minimum obstruction to the view of the production process. (Wire mesh, grating, or panel fence)
- The fence is located at an adequate distance from the maximum space of the robot.
- The fence should be connected to PE (protective earth) to prevent the electric shock.
- Refer to the following related standards for details such as the size of the opening and the minimum size of the grating.
 - EN ISO 13855
 - EN ISO 13857
 - ANSI B11.19

4.7.2 Safety Gate and Plugs

The requirements for the safety gate are as follows.

- The interlock prevents the robot system from automatic operation until the guard is closed.
- The closure of the guard must not be the control to restart automatic operation. This must be a deliberate action at a control station.
- The gate must be equipped with plugs and sockets for interlock. The plugs and sockets must be selected appropriate ones for safety.

This guard must remain locked and closed until the risk of injury from the hazard has ceased (interlocking guard with guard locking). Alternatively, when the guard is opened while the robot system is working, a stop or emergency stop instruction (interlocking guard) is given.

Refer to EN/ISO 14119 or ANSI B11.19 for details of the interlocking devices.

It is recommended to install a device preventing the gate from being accidentally closed when personnel can fully enter the safeguarded space through the gate with interlocking devices.

Care should be taken to ensure that actuation of an interlock installed to protect against one hazard (e.g. stopping hazardous motion of the robot system) does not create other hazards (e.g. the release of hazardous substances into the work zone).

4.7.3 Other Protection Devices

Protection devices must be designed and incorporated into the control system so that:

- moving parts cannot start up while they are within the operator's reach,
- the person cannot reach moving parts once they have started up,
- they can be adjusted only by means of an intentional action, such as the use of a tool, key, etc.,
- the absence or failure of one of their components prevents starting or stops the moving parts.

If some presence sensing devices are used for safety purposes, they must comply with the following.

- A presence sensing device must be installed and arranged so that persons cannot enter and reach into a hazardous area without activating the device.
- A presence sensing device must be installed and arranged so that persons cannot reach the restricted space before the hazardous conditions have ceased.
- Barriers used in conjunction with the presence-sensing device may be required to prevent persons from bypassing the device.
- Their operation must not be adversely affected by any of the environmental conditions for which the system was intended.
- When a presence sensing device has been activated, it may be possible to restart the robot system from the stopped position provided that this does not create other hazards.
- Resumption of robot motion must require the removal of the sensing field interruption. This must not be the control to restart automatic operation.

4.8 OPERATION INSIDE OF THE SAFETY FENCE

When some workers (programmer, maintenance technician) have to enter the safety fence, the following care has to be taken into account.

- Make sure that the robot has been completely stopped before entering the safety fence. Never enter the safety fence during the robot moving. If the robot is moving, stop the robot by the hold button (or input signal), and after "controlled stopping" or "smooth stopping" it (servo power off), then you can enter the safety fence.
- Make sure that an indicator lamp for stop condition shows the stopped status of the robot, and enter the safety fence from the safety gate.
- To inform you are working in the safety fence, display "working". During robot teaching or test operation, robot may move to an unexpected direction. Exercise special care, and perform teaching in the position where you can escape from the robot in case of a dangerous situation.
- Enable the "safe reduced speed" signal.
- When more than one worker collaborates for their operation, a person in charge should be equipped with the teach pendant, and other workers have to follow his or her order. Any operations from the external interface and robot controller operator's panel without his or her order have to be prohibited.
- All workers inside of the safety fence always have to secure the escape zone to avoid hazards from unintended movement of the robot.
- Care should be taken by all workers not to close off the escape routes for other personnel.
- Do not operate the robot while resting against the wall, apparatus installed inside of the safety fence, etc. that hinders or removes the operator's escape route.
- Always watch the robot while jogging, during program verification, etc.
- Stop the robot immediately by the E-stop button when somebody recognizes a dangerous situation. Whenever possible, other operators who have access to the E-stop button should keep watch from outside of the safety fence.
- Make sure that a teach pendant enabling device (DEADMAN switch) is operated only by holding it with a hand.
- Make sure that no personnel exist inside of the safety fence when closing the safety gate.
- Do not leave tools etc. inside of the motion range of the robot or peripheral devices when operation inside of the safety fence has been finished.



WARNING

- 1 Safety procedures for entering the safety fence have to be established and observed. Improper procedure for entering the safety fence can cause serious injury or death of personnel due to hazards such as being pinched by the robot arm.
- 2 During teaching or maintenance of the robot system, special care shall be taken so that any other personnel who is not work for these operations does not enter the safety fence. Unauthorized entry to the inside of the safety fence can cause serious injury or death of personnel due to hazards such as being pinched by the robot arm.

4.9 SAFETY PROCEDURES FOR ENTERING THE SAFETY FENCE

This section describes an example of the safety procedures for entering the safety fence.

Note that only a programmer or a maintenance technician can enter the safety fence. Any other person (including an operator) CANNOT enter the safety fence.

Entering into the SAFETY FENCE

Situation: The robot is moving automatically (in AUTO mode).

- 1 Stop the robot by pressing the [HOLD] button or the HOLD input signal.
- 2 Change the operating mode to T1 or T2 from AUTO with the MODE SELECT switch.
- 3 Remove the key to the MODE SELECT switch for mode lock.
- 4 Remove safety plug 2 from socket 2.
- 5 Open the safety gate of the safety fence, and insert safety plug 2 removed in step 4 into socket 4.
- 6 Remove safety plug 1 from socket 1.
- 7 Enter inside the safety fence, and insert safety plug 1 removed in step 6 into socket 3.

Refer to Fig.4.9 (a) for details of the safety fence, safety plug, and socket configurations.

The key to the MODE SELECT switch and safety plug 1 must be carried into the safety fence by the person entering the fence.

Safety plug 1 must be inserted into socket 3 inside the fence.

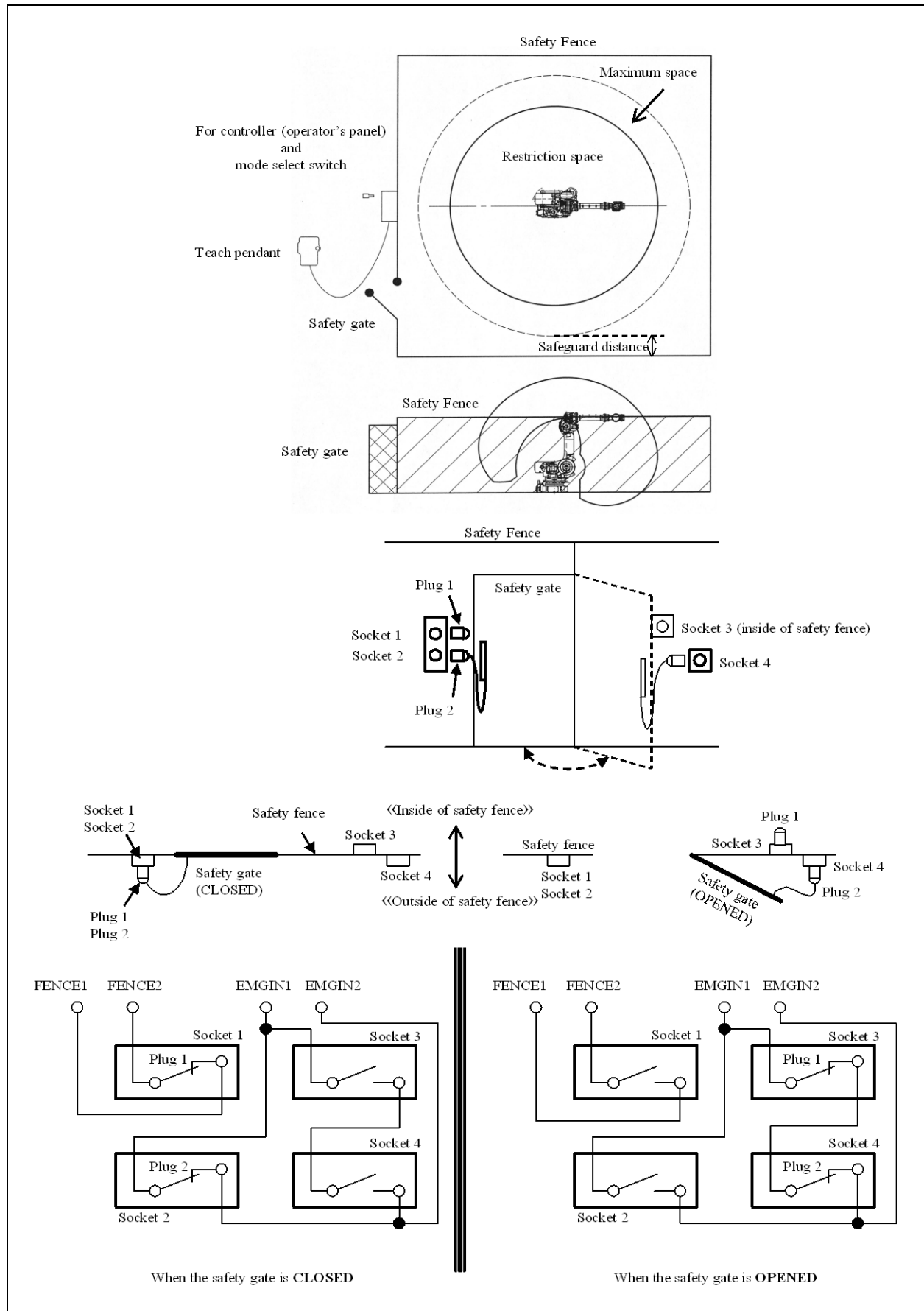


Fig. 4.9 (a) Safety Fence and Safety Gate example

5 GENERAL CAUTIONS

This chapter describes the safety requirements for the following situations:

- Installation (5.1)
- Commissioning and functional testing (5.2)
- Precaution for mechanism (5.3)
- Programming (5.4)
- Program verification (5.5)
- Troubleshooting (5.6)
- Saving programmed data (5.7)
- Automatic operation (5.8)
- Maintenance (5.9)
- Safety of maintenance technician (5.10)
- Dismantling / scrapping (5.11)
- Other cautions (5.12)

The user must ensure that the safeguarding methods are provided, utilized, and maintained for each operation associated with the robot system and in particular for personnel other than those utilizing the teach pendant or enabling device.

The user must ensure that a teach pendant not connected to the robot controller must be inaccessible.



WARNING

- 1 Safety procedures for entering the safety fence have to be established and observed. Improper procedure for entering the safety fence can cause serious injury or death of personnel due to hazards such as being pinched by the robot arm.
- 2 During teaching or maintenance of the robot system, special care shall be taken so that any personnel not performing these operations does not enter the safety fence. Unauthorized entry to the inside of the safety fence can cause serious injury or death of personnel due to hazards such as being pinched by the robot arm.



CAUTION

The servo motors, the regenerative resistor units and the isolated transformers on the AC power supply may be hot even after robot operation. Touching the surface of these components should be therefore avoided as much as possible. When touching any of these components is nonetheless required (ex.: for maintenance purposes), special care must be applied in order to avoid burn injury due to high temperatures.

5.1 INSTALLATION

The robot system must be installed in accordance with FANUC's requirements. The safeguarding methods must be identified by the hazard analysis and the risk assessment. The user must review the safety requirements to ensure that the appropriate safeguards are applied and operational prior to use in production.

5.2 COMMISSIONING AND FUNCTIONAL TESTING

Specify the procedures that must be followed during robot or robot systems testing after installation or relocation. These procedures are also applied to robots or robot systems after modifications (e.g. changes in hardware or software, replacement of parts, adjustments) and after maintenance or repairs that can adversely affect their safe operation.

5.2.1 Designation of the Restricted Space

When the safeguarding methods are not in place prior to commissioning and functional testing, an interim means of designating the restricted space must be in place before proceeding.

5.2.2 Restriction of Personnel

During the commissioning and functional testing, personnel must not be allowed in the safeguarded space until the safeguarding is functional.

5.2.3 Safety and Operational Verification

Follow the instructions by the manufacturer (FANUC) for the commissioning and functional testing of the robot or the robot system.

At the initial start-up, the following matters must be included (but not limited to).

Before applying power, verify that

- The robot has been properly mechanically mounted and is stable
- The electrical connections are correct and the power supply (i.e. voltage, frequency, interference levels) is within specified limits
- The other utilities (e.g. water, air, gas) are properly connected and within specified limits
- The peripheral equipment is properly connected
- The limiting devices that establish the restricted space (when utilized) are installed
- The safeguarding means are applied
- The physical environment is as specified (e.g. lighting and noise levels, temperature, humidity, atmospheric contaminants)

After applying power, verify that

- The start, stop, and mode selection control devices function as intended
- Each axis moves, and the movement of the axis is restricted as intended
- Emergency stop circuits and devices are functioning correctly
- The safeguards and interlocks function correctly
- It is possible to disconnect and isolate the external power sources
- The teach and playback facilities function correctly
- Other safeguarding is in place (e.g. barriers, warning devices)
- In a safe reduced speed, the robot operates properly and has the capability to handle the product or workpiece
- In automatic (normal) operation, the robot operates properly and has the capability to perform the intended task at the rated speed and load

5.2.4 Robot System Restart Procedures

A procedure to restart the robot system after hardware, software or task program modification, repair, or maintenance must include but not necessarily be limited to the following:

- Check any changes or additions to the hardware prior to applying power
- Functionally test the robot system for proper operation

5.3 PRECAUTIONS FOR THE MECHANICAL UNIT

- (1) Keep the component cells of the robot system clean, operate the robot where insulated from the influence of oil, water, and dust.
- (2) Don't use an unconfirmed liquid as a cutting or cleaning fluid.
- (3) Adopt limit switches, DCS, or mechanical stoppers to limit the robot motion, and restrict the robot from colliding against peripheral equipment or tools.
- (4) Observe the following precautions about the mechanical unit cables. Failure to follow precautions may cause problems.
 - Use mechanical unit cable that have required user interface.
 - Do not route user cables or hoses inside of the mechanical unit.
 - Do not obstruct the movement of the mechanical unit when cables are added to the outside of the mechanical unit.
 - When FANUC supplies a robot with cables routed on the outside of the robot, please do not perform remodeling (Adding a protective cover and fix an outside cable more) obstructing the behavior of the outcrop of the cable.
 - When installing user peripheral equipment on the robot mechanical unit, be sure that the device does not interfere with the robot itself.
- (5) The frequent power-off stop for the robot during operation causes the trouble of the robot. Please avoid the system construction that power-off stop would be operated routinely. (Refer to bad case example.) Please perform power-off stop after reducing the speed of the robot and stopping it by hold stop or cycle stop when it is not urgent. (Please refer to "STOP TYPE OF ROBOT" in Chapter 4 for detail of stop type.)

(Bad case example)

 - Whenever a poor product is generated, a line stops by emergency stop and robot power-off occurs.
 - When alteration is necessary, a safety switch is operated by opening the safety fence and a power-off stop occurs during operation.
 - An operator pushes the emergency stop button frequently, and a line stops.
 - An area sensor or a mat switch connected to safety signal operates routinely and a robot power-off stop occurs.
 - Power-off stop is regularly incurred due to an inappropriate setting for Dual Check Safety (DCS).
- (6) A robot power-off stop is executed when a collision detection alarm (SRVO-050) etc. occurs. Avoid unnecessary power-off stops that may cause the robot mechanical problems. Therefore, remove the causes of the alarm.

5.4 PROGRAMMING

Whenever possible, programming must be performed with all persons outside the safeguarded space. When it is necessary to perform programming with personnel inside the safeguarded space, the following safety procedures are necessary.



WARNING

No other personnel than a programmer or teaching operator enter the safety fence during teaching. Unauthorized entry to the inside of the safety fence can cause serious injury or death of personnel due to hazards such as being pinched by the robot arm.

5.4.1 Prior to Programming

The following conditions must be met prior to programming.

- The programmer must be trained on the type of robot used in the actual robot system and must be familiar with the recommended programming procedures including all of the safeguarding methods.
- The programmer must visually check the robot system and safeguarded space to ensure that extraneous conditions which can cause hazards do not exist.
- Where required for programming, the teach pendant must be tested to ensure proper operation.
- Any faults or failures in the robot system must be corrected prior to starting programming.
- Before entering the safeguarded space, the programmer must ensure that all necessary safeguards are in place and functioning correctly.
- The programmer must set the operating mode T1 (or T2) from AUTO and must take any measure to prevent other personnel from initiating automatic operation prior to entering the safeguarded space.
- Operators should be ungloved while manipulating the operator panel or teach pendant. Operation with gloved fingers could cause an operation error.

5.4.2 During Programming

During programming, only the programmer must be allowed in the safeguarded space and the following conditions must be met.

- The robot system must be under the sole control of the programmer within the safeguarded space. (When T1 or T2 mode is selected, the robot can be moved only by the teach pendant. The programmer shall set the robot to an appropriate speed.)
- The controls of the teach pendant must be used as intended.
- The robot system must not respond to any remote commands or conditions that would cause hazardous conditions.
- Movement of other equipment in the safeguarded space which can present a hazard must either be prevented or under the sole control of the programmer. When under control of the programmer, it must require a deliberate action on the part of the programmer separate from the action to initiate robot motion.
- All robot system emergency stop devices must remain functional. When they are not functional, a measure must be taken so that the safety of personnel is ensured.

5.4.3 Returning to Automatic Operation

The programmer must return the suspended safeguards to their original effectiveness prior to initiating automatic operation of the robot system.

5.5 PROGRAM VERIFICATION

When visual examination of the robot system response to the task program is necessary as part of the verification procedure, it should be made with all persons outside the safeguarded space. When it is necessary to perform program verification with personnel inside the safeguarded space, the following must apply:

- Program verification must initially be performed at a safe, reduced speed.
Caution must be exercised particularly when override is specified in the program.
- When it is necessary to examine the movement of the robot at full (operational) speed, the following requirements must apply:
 - Suspension of the safe reduced speed must be done only by the programmer using means that require a deliberate action;
 - An enabling device or a device with an equivalent safety level must always be available to personnel within the safeguarded space;
 - Safe work procedures are established to minimize the exposure of personnel to hazards within the safeguarded space.
- When a program is completed, be sure to carry out a test operation according to the following procedure.
 - (a) Run the program for at least one operation cycle in the single step mode at a low speed.
 - (b) Run the program for at least one operation cycle in continuous operation at a low speed.
 - (c) Run the program for one operation cycle in continuous operation 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 continuous operation at the normal operating speed and check that the system operates automatically without trouble.
 - (e) After checking the completeness of the program through the test operation above, execute it in the automatic operation.
- While operating the system in automatic operation, the programmer shall leave the safety fence.

5.6 TROUBLESHOOTING

Troubleshooting should be performed from outside the safeguarded space. When this is not possible, and the robot system has been designed to perform troubleshooting from within the safeguarded space, the following requirements must apply:

- Personnel responsible for troubleshooting are specifically authorized and trained for these activities;
- Personnel entering the safeguarded space must use the enabling device to allow motion of the robot;
- Safe work procedures are established to minimize the exposure of personnel to hazards within the safeguarded space.

5.7 STORING PROGRAMMED DATA

A record of the task programs together with any modifications should be stored.

The media to which programmed data are saved must be stored in a suitably protected environment when not in use.

5.8 AUTOMATIC OPERATION

Automatic operation must only be permissible when

- The intended safeguards are in place and functioning normally
- No personnel are present within the safeguarded space
- Proper safe work procedures are provided and followed



WARNING

Make sure that no person are inside the safety fence before starting up automatic operation of the robot system. If automatic operation is performed while somebody is still inside the safety fence, he or she might meet serious situation, which can lead them to serious injury or death.

5.9 MAINTENANCE

An inspection and maintenance procedure manual for the robot and robot system must be prepared to ensure their continued safe operation. The inspection and maintenance procedure manual must be prepared with the robot and robot system manufacturer's recommendations taken into account.

Personnel who perform maintenance or repair on robots or a robot system must be sufficiently trained in the procedures necessary to safely perform the required tasks.

Personnel who perform maintenance or repair on the robot system must be safeguarded from hazards.

Where possible, maintenance must be performed from outside the safeguarded space with the robot arm placed in a predetermined position.

The following is the safety procedure for entering the safeguarded space when it is necessary to perform maintenance within the safeguarded space.



WARNING

Power to the robot system has to be disconnected by the main breaker whenever possible during maintenance. Maintenance without disconnection of power to the robot system can cause electric shock to personnel who touch high-voltage part.

Entering safeguarded space for maintenance

- 1 Stop the robot system.
- 2 Shut off the power to the robot system, and lock the main breaker to prevent powering on during maintenance, by mistake.

If you have to enter the safeguarded space while power is available to the robot system, you must perform the following prior to entering the safeguarded space:

Check the robot system to see if any conditions exist that are likely to cause malfunctions

Check if the teach pendant works correctly

If any damage or malfunction is found, complete the required corrections and perform a retest before personnel enter the safeguarded space

- 3 Enter the safeguarded space (refer to Section 4.7).
- 4 After the maintenance is complete, check if the safeguard system is effective. When interrupting the maintenance work, return the system to the original effectiveness.

5.10 SAFETY OF THE MAINTENANCE TECHNICIAN

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

- (1) During operation, never enter the robot operating space.
- (2) A hazardous situation may arise when the robot or the system, are kept with their power-on during maintenance operations. Therefore, for any maintenance operation, the robot and the system should be put into the power-off state. If necessary, a lock should be in place in order to prevent any other person from turning on the robot and/or the system. In case maintenance needs to be executed in the power-on state, the emergency stop button must be pressed.
- (3) If it becomes necessary to enter the robot operating space while the power is on, press the emergency stop button on the operator box or operator panel, or the teach pendant before entering the range. The maintenance technician must indicate that maintenance work is in progress and be careful not to allow other people to operate the robot carelessly. (See Section 4.7.)
- (4) When entering the area enclosed by the safety fence, the worker must check the whole robot system in order to make sure no dangerous situations exist. In case the worker needs to enter the safety area whilst a dangerous situation exists, extreme care must be taken, and whole robot system status must be carefully monitored.
- (5) Before maintenance of the pneumatic system, shut off the supply pressure and reduce the pressure in the piping to zero.
- (6) Before the start of maintenance work, check that the robot and its peripheral equipment are all in normal operating condition.
- (7) Do not operate the robot in the automatic operation while anybody is in the robot operating space.
- (8) When you maintain the robot alongside a wall or instrument, or when multiple users are working nearby, make certain that their escape path is not obstructed.
- (9) When a tool is mounted on the robot, or when any movable device other than the robot is installed, such as belt conveyor, pay careful attention to its motion.
- (10) If necessary, have a user who is familiar with the robot system stand beside the operator panel and observe the work being performed. If any danger arises, the user should be ready to press the EMERGENCY STOP button at any time.
- (11) When replacing a part, contact your local FANUC representative. Following an incorrect replacement procedure may cause an accident which could injure personnel or damage equipment.
- (12) When replacing or reinstalling components, take care to prevent foreign material from entering the system.
- (13) When handling each unit or printed circuit board in the controller during inspection, turn off the circuit breaker to protect against electric shock.
If there are two cabinets, turn off the both circuit breaker.
- (14) Replace parts only with FANUC-approved replacement parts. Other parts could malfunction or damage the robot. Especially, a fuse that is not recommended by FANUC should not be used. Such a fuse may cause a fire.
- (15) When restarting the robot system after completing maintenance work, make sure in advance that no personnel exist in the operating space and that the robot and the peripheral equipment are not in an abnormal condition.
- (16) When a motor or brake is removed, the robot arm should be supported with a crane or other equipment beforehand so that the arm does not fall during the removal.
- (17) Whenever grease is spilled on the floor, it should be removed as quickly as possible to prevent dangerous falls.
- (18) The following parts get hot. If a maintenance worker needs to touch such a part in the heated state, the user should wear heat-resistant gloves or use other protective tools.
 - Servo motor
 - Inside the controller
 - Reducer
 - Gearbox
 - Wrist unit

- (19) Maintenance should be done under suitable light. Care must be taken that the light would not cause any danger.
- (20) When a motor, reducer, or other heavy load is handled, use a crane or other equipment to protect maintenance workers from excessive load. Otherwise, the maintenance workers could be severely injured.
- (21) The robot should not be stepped on or climbed upon during maintenance. If it is attempted, the robot could be adversely affected. In addition, a misstep can injure personnel.
- (22) When performing maintenance work in high places, secure a footstep and utilize proper fall protection measures.
- (23) After the maintenance is completed, all spilled oil or water and metal chips should be removed from the floor around the robot and within the safety fence.
- (24) When a part is replaced, all bolts and other related components should be replaced in their original location. A careful check must be made to ensure that no components are missing or are left unmounted.
- (25) If robot motion is required during maintenance, take the following precautions:
 - Foresee an escape route. During the maintenance motion itself, monitor continuously the whole robot system so that your escape route will not become blocked by the robot, or by peripheral equipment.
 - Always pay attention to potentially dangerous situations, and be prepared to press the emergency stop button whenever necessary.
- (26) The robot should be periodically inspected. (Refer to the robot mechanical manual and controller maintenance manual.) A failure to do the periodic inspection can adversely affect the performance or service life of the robot and may cause an accident
- (27) After a part is replaced, the robot should be tested according to a predetermined method. (See the TESTING section of the controller-specific software operator's manual or the Software Installation Manual.) During the test execution, the maintenance worker should work outside of the safety fence.

5.11 DISMANTLING / SCRAPPING

Do not start dismantling the robot before contacting FANUC Corporation in Japan, FANUC Europe Corporation, FANUC America Corporation or other group companies.

Contact us when you dismantle/scrap FANUC robot systems.

WARNING

- 1 Dismantling/scrapping a FANUC robot system must be done in compliance with the related instructions provided by FANUC. Inappropriate method of dismantling/scrapping may lead to falling over of the robot due to the loss of mechanical balance of the robot or part of it, and cause very severe injury or death of personnel.
- 2 When dismantling and/or scrapping robot mechanical units equipped with spring balancers, the robot arm may move unexpectedly due to the stored elastic energy of the springs inside the balancer(s), and subsequently, the robot or part of it may lose its balance and fall over, resulting in very severe injury or death of personnel.
Dismantling and scrapping of such a robot mechanical unit must be done by following the instructions provided by FANUC only after releasing the stored energy.
- 3 Dismantling/scrapping a spring balancer must be done in compliance with the related instructions provided by FANUC. Dismantling/scrapping a robot inappropriately may lead to the loss of mechanical balance of the robot, and cause severe injury, death of personnel, or equipment damage.

CAUTION

Robot batteries used for memory and/or encoder backup must be disposed of appropriately. Failure to do so may cause a short circuit during dismantling/scrapping, which potentially can cause the battery to ignite or explode.

5.12 OTHER CAUTIONS

Some robot models have motors without brakes. Such models may be moved slowly by the force of gravity when the servo power is cut off.

Be careful of their movement when using a robot that use motors without brakes or you could injure personnel or damage equipment.

6 DAILY MAINTENANCE

6.1 MECHANICAL UNIT

To keep the robot system safe, perform periodic maintenance specified in the robot-specific maintenance manual.

In addition, clean each part of the system and visually check them for any damage or cracks.

Daily check items are (but are not limited to) the following:

- Input power voltage
- Pneumatic pressure
- Damage of connection cables
- Looseness of connectors
- Lubrication
- Emergency stop functions
- Effectiveness of Enabling switch (deadman switch) on the teach pendant
- Safety gate interlocks
- Vibration, noise by the robot movement
- Functions of peripheral devices
- Fixtures of robot and peripheral devices

6.2 CONTROL UNIT (CONTROLLER)

Before operating the system each day, clean each part of the system and visually check the system parts for any damage or cracks.

Also, check the following:

(a) Before service operation

- Check the cable connected to the teach pendant for excessive twisting.
- Check the controller and peripheral equipment for abnormalities.
- Check the safety function.

(b) After service operation

At the end of service operation, return the robot to the proper position, then turned off the controller. Clean each part, and check for any damage or cracks.

If the ventilation port and the fan motor of the controller are dusty, wipe off the dust.

7 EU DECLARATION OF CONFORMITY

For FANUC Robot series (for CE marking : both of the following labels are attached), EU declarations of conformity with the following contents are applied.

Label for CE marking (on the robot mechanical unit)



Label for CE marking (on the robot controller)



*NOTE:
Value of "WEIGHT" and "INPUT VOLTAGE" depend on the robot controller specification.

Contents of EU declarations of conformity for Machinery Directive (2006/42/EC)

Item	Contents	
	Machinery Directive (2006/42/EC)	EMC Directive (2014/30/EU) Low Voltage Directive (2014/35/EU)
Name of the manufacturer	FANUC CORPORATION	
Address of the manufacturer	3580 Komanba, Shibokusa Oshino-mura, Minamitsuru-gun Yamanashi Prefecture, 401-0597 Japan	
Model	Please refer to "operator's manual" for each robot models. At the beginning of "PREFACE", following information is listed. Model : "Model name" Designation : "Mechanical unit specification No."	
Designation		
Applied standards	EN ISO 10218-1:2011 EN 60204-1:2006+A1	EN 55011:2009+A1 (2014/30/EU) EN 61000-6-2:2005 (2014/30/EU) EN 60204-1:2006+A1 (2014/35/EU)
Importer/Distributor in EU	FANUC EUROPE CORPORATION 7, rue Benedikt Zender L-6468 Echternach	
Date	Date of manufacture (to be written in EC declaration of conformity attached for each robot system)	

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REVISION RECORD

Edition	Date	Contents
17	Nov., 2020	<ul style="list-style-type: none"> • Additional description of Smooth stop upgrade option • Additional description of R-30iB Mini Plus controller • Correction of errors
16	Oct., 2019	<ul style="list-style-type: none"> • Correction of errors
15	Jan., 2018	<ul style="list-style-type: none"> • Addition of 1 SAFETY PRECAUTIONS • Additional description of R-30iB Compact Plus controller • Correction of errors
14	May, 2017	<ul style="list-style-type: none"> • Additional description of R-30iB Plus, R-30iB Mate Plus controller • Correction of errors
13	Aug., 2016	<ul style="list-style-type: none"> • Applied to new European EMC directive (2014/30/EU), new low voltage directive, and review • Correction of errors
12	Sep., 2014	<ul style="list-style-type: none"> • Additional description of definition of CAUTION and WARNING
11	Aug., 2014	<ul style="list-style-type: none"> • Additional description of CAUTION and WARNING
10	Dec., 2012	<ul style="list-style-type: none"> • Additional description of R-30iB Mate controller
09	Mar., 2012	<ul style="list-style-type: none"> • Additional description for North America NRTL compliance and R-30iB controller
08	Sep., 2010	<ul style="list-style-type: none"> • Applied to New Machinery Directive 2006/42/EC Review of all
07	Sep., 2009	<ul style="list-style-type: none"> • Applied to 2006/42/EC
06	Nov., 2008	<ul style="list-style-type: none"> • Additional descriptions for North America NRTL compliance
05	Jan., 2008	<ul style="list-style-type: none"> • Applied to EN ISO10218
04	Oct., 2005	<ul style="list-style-type: none"> • All pages are changed.
03	Apr., 2001	<ul style="list-style-type: none"> • Additional descriptions for R-J3i MODEL B Controller.
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