

SAFETY PRECAUTIONS

Be sure to observe all of the following safety precautions.

Strict observance of these warning and caution indications are a **MUST** for preventing accidents, which could result in bodily injury and substantial property damage. Make sure you fully understand all definitions of these terms and related symbols given below, before you proceed to the text itself.

 WARNING	Alerts you to those conditions, which could result in serious bodily injury or death if the instructions are not followed correctly.
 CAUTION	Alerts you to those conditions, which could result in minor bodily injury or substantial property damage if the instructions are not followed correctly.

Terminology and Definitions

Maximum space: Refers to the space which can be swept by the moving parts of the robot as defined by the manufacturer, plus the space which can be swept by the end-effector and the workpiece. (Quoted from the ISO 10218-1:2006.)

Restricted space: Refers to the portion of the maximum space restricted by limiting devices (i.e., mechanical stops) that establish limits which will not be exceeded. (Quoted from the ISO 10218-1:2006.)

Motion space: Refers to the portion of the restricted space to which a robot is restricted by software motion limits. The maximum distance that the robot, end-effector, and workpiece can travel after the software motion limits are set defines the boundaries of the motion space of the robot. (The "motion space" is DENSO WAVE-proprietary terminology.)

Refers to a set of instructions for motion and auxiliary functions that define the specific intended task of the robot system. (Quoted from the ISO 10218-1:2006.)

Operating space: Refers to the portion of the restricted space that is actually used while performing all motions commanded by the task program. (Quoted from the ISO 10218-1:2006.)

Task program: Refers to the portion of the restricted space to which a robot is restricted by software motion limits. The maximum distance that the robot, end-effector, and workpiece can travel after the software motion limits are set defines the boundaries of the motion space of the robot. (The "motion space" is DENSO WAVE-proprietary terminology.)

Refers to a set of instructions for motion and auxiliary functions that define the specific intended task of the robot system. (Quoted from the ISO 10218-1:2006.)

1. Introduction

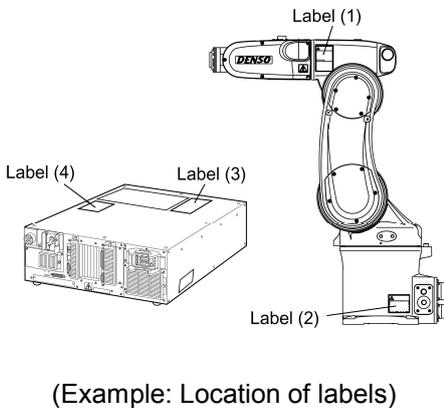
This section provides safety precautions to be observed for the robot system.

The installation shall be made by qualified personal and should confirm to all national and local codes.

Those who operate or maintain the robot, please receive special educations of robot based on regulations.

2. Warning Labels

The robot unit and controller have warning labels. These labels alert the user to the danger of the areas on which they are pasted. Be sure to observe the instructions printed on those labels.



Warning label	Instructions printed on the label
 <p>Label (1)</p>	<p>Risk of injury. Never enter the restricted space.</p>
<p><Except HM></p>  <p><HM></p>  <p>Label (2)</p>	<p><u>For UL-Listed robot units only</u></p> <p>Risk of injury. This label alerts the user that pressing the brake release switch could drop the arm.</p>
 <p>Label (3)</p>	<p>Risk of electrical shock. Never open the controller cover when the power is on. Never touch the inside of the controller for at least 3 minutes even after turning the power off and disconnecting the power cable.</p>
 <p>Label (4)</p>	<p>Risk of injury. Be sure to perform lockout/tagout before starting servicing. Turning the power ON when a person is inside the safety fence may move the arm, causing injuries.</p>

3. Installation Precautions

3.1 Insuring the Proper Installation Environment

■ For Standard Type and Cleanroom Type

The standard and cleanroom types have not been designed to withstand explosions, dust-proof, nor is it splash-proof. Therefore, it should not be installed in any environment where:

- (1) there are flammable gases or liquids,
- (2) there are any shavings from metal processing or other conductive material flying about,
- (3) there are any acidic, alkaline or other corrosive material,
- (4) there is a mist,
- (5) there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise.

■ For Dust- & Splash-proof Type

The dust- & splash-proof type has an IP54-equivalent structure, but it has not been designed to withstand explosions. (The HM/HS-W and the wrist of the VM/VS-W are an IP65-equivalent dust- and splash-proof structure.)

Note that the robot controller is not a dust- or splash-proof structure. Therefore, when using the robot controller in an environment exposed to mist, put it in an optional protective box.

The dust- & splash-proof type should not be installed in any environment where:

- (1) there are any flammable gases or liquids,
- (2) there are any acidic, alkaline or other corrosive material,
- (3) there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise,
- (4) it may likely be submerged in fluid,
- (5) there are any grinding or machining chips or shavings,
- (6) any machining oil not specified in this manual is in use, or
Note: Yushiron Oil No. 4C (non-soluble) is specified.
- (7) there is sulfuric cutting or grinding oil mist.

3.2 Service Space

The robot and peripheral equipment should be installed so that sufficient service space is maintained for safe teaching, maintenance, and inspection.

3.3 Control Devices Outside the Robot's Restricted Space

The robot controller, teach pendant and mini-pendant should be installed outside the robot's restricted space and in a place where you can observe all of the robot's movements and operate the robot easily.

The teach pendant, mini-pendant should be installed so as to be able to distinguish each combination of the emergency stop switch and the robot to prevent pressing wrong emergency stop switches when emergency stop execution.

3.4 Positioning of Gauges

Pressure gauges, oil pressure gauges and other gauges should be installed in an easy-to-check location.

3.5 Protection of Electrical Wiring and Hydraulic/Pneumatic Piping

If there is any possibility of the electrical wiring or hydraulic/pneumatic piping being damaged, protect them with a cover or similar item.

Be careful not to apply too much pressure on the joint.

3.6 Grounding Resistance

The protective grounding resistance of the robot power supply should not be more than 100Ω.

3.7 Positioning of Emergency Stop Switches

Based on ISO13850, emergency stop switches should be provided in a position where they can be reached easily should it be necessary to stop the robot immediately.

3.8 Positioning of Operating Status Indicators

Operating status indicators should be positioned in such a way where workers can easily see whether the robot is on a temporary halt or on an emergency or abnormal stop.

TIP: The UL-Listed robot units have motor ON lamps on their robot arms.

3.9 Precautions for Transporting and Installation of the Robot Unit

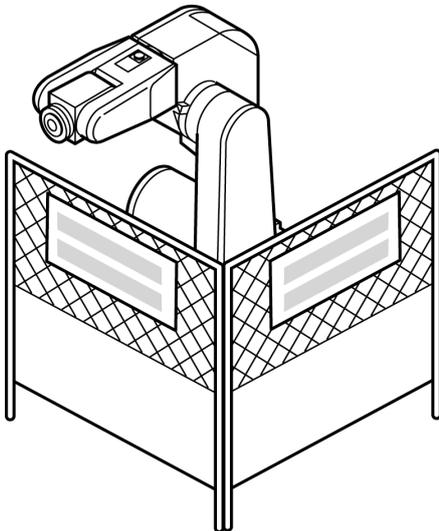
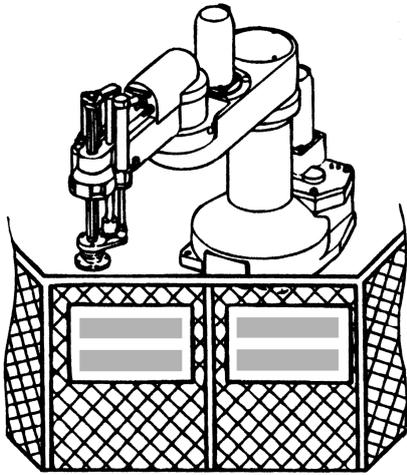
Transporting or installation should be handled by at least two people, except for lightweight small robots which are allowed to operate by one person.

Use a crane or a lift with suitable capacity to avoid unreasonable manual operation.

Pass the hoisting wires through the specified eyebolts. Passing them through other sections may drop the robot unit, resulting in a broken robot or bodily injuries.

Transporting should be handled by at least two people, while wearing a helmet, safety shoes, and gloves.

3.10 Setting-up a Safety Fence



A safety fence should be set up so that neither operator nor third person can easily enter the robot's restricted space. Safety fences should be set up based on user's risk assessment.

- (1) The fence should be constructed so that it cannot be easily moved or removed.
- (2) The fence should be constructed so that it cannot be easily damaged or deformed through external force.
- (3) Establish the exit/entrance to the fence. Construct the fence so that neither operator nor third person can easily get past it by climbing over the fence.
- (4) The fence should be constructed to ensure that it is not possible for hands or any other parts of the body to get through it.
- (5) Take any one of the following protections for the entrance/exit of the fence:
 - 1) Place a door, rope or chain across the entrance/exit of the fence, and fit it with an interlock that ensures the emergency stop device operates automatically if it is opened or removed.
 - 2) Post a warning notice at the entrance/exit of the fence stating "In operation--Entry forbidden" or "Work in progress--Do not operate" and ensure that workers follow these instructions at all times.
- (6) When making a test run, before setting up the fence, place an overseer in a position outside the robot's restricted space and one in which he/she can see all of the robot's movements. The overseer should prevent workers from entering the robot's restricted space and be devoted solely to that task.

3.11 Setting the Robot's Motion Space

The area required for the robot to work is called the robot's operating space.

If the robot's motion space is greater than the operating space, it is recommended that you set a smaller motion space to prevent the robot from interfering or disrupting other equipment.

3.12 No Robot Modification Allowed

Never modify the robot unit, robot controller, teach pendant or other devices.

3.13 Cleaning of Tools

If your robot uses welding guns, paint spray nozzles, or other end-effectors requiring cleaning, it is recommended that the cleaning process be carried out automatically.

3.14 Lighting

Sufficient illumination should be assured for safe robot operation.

3.15 Protection from Objects Thrown by the End-effector

If there is any risk of workers being injured in the event that the object being held by the end-effector is dropped or thrown by the end-effector, consider the size, weight, temperature and chemical nature of the object and take appropriate safeguards to ensure safety.

3.16 Affixing the Warning Label

Place the warning label packaged with the robot on the exit/entrance of the safety fence or in a position where it is easy to see.



3.17 Posting the Moving Directions of All Axes

Post a notice showing axes names and moving directions in a visible location on the robot unit. The posted moving directions should match the actual directions.

No posting or wrong direction posting may result in bodily injuries or property damages due to incorrect operation.

3.18 Changing the Configuration

When the components of the robot system or optional devices (including hardware and software) have been changed or added, carry out necessary tests or inspections of safety functions.

4. Precautions while Robot is Running



Touching the robot while it is in operation can lead to serious injury. Please ensure the following conditions are maintained and that the cautions listed from onwards are followed when any work is being performed.



- 1) Do not enter the robot's restricted space when the robot is in operation or when the motor power is on.
- 2) As a precaution against malfunction, ensure that an emergency stop device is activated to cut the power to the robot motor upon entry into the robot's restricted space.
- 3) When it is necessary to enter the robot's restricted space to perform teaching or maintenance work while the robot is running, ensure that the steps described in "Ensuring safety of workers performing jobs within the robot's restricted space" are taken.

NOTE: A "work" as is defined in this section includes all operations such as transportation, installation, assembling the robot facilities, (electric wiring, mounting tool or end-effector, air piping) adjustment, anomalous correspondence procedure in case of abnormal situations, maintenance, cleaning.

4.1 Installing Protective Equipment

Workers who engage in this operation shall be install protective equipment, such as helmet, protective shoes, gloves and protective glasses.

When treating grease, make sure to wear gloves and protective glasses to prevent the grease from adhering to skin and eyes.

4.2 Precautions for transportation and installation

When transportation or installation of the robot (except robots which is allowed to handle one person, such as light-weight robot), be sure to work two or more people. Use crane or lift to avoid excessive manual handling.

Wire must be fixed to the hoisting bolt (eye bolt). If other than the hoisting bolt is used, it may cause a serious damage.

Do not stay under the robot during operation.

4.3 Creation of Working Regulations and Assuring Worker Adherence

When entering the robot's restricted space to perform teaching or maintenance inspections, set "working regulations" for the following items and ensure workers adhere to them.

- (1) Operating procedures required to run the robot.
- (2) Robot speed when performing teaching.
- (3) Signaling methods to be used when more than one worker is to perform work.
- (4) Steps that must be taken by the worker in the event of a malfunction, according to the contents of the malfunction.
- (5) The necessary steps for checking release and safety of the malfunction status, in order to restart the robot after robot movement has been stopped due to activation of the emergency stop device.
- (6) Apart from the above, any steps below necessary to prevent danger from unexpected robot movement or malfunction of the robot.
 - 1) Display of the control panel.
 - 2) Assuring the safety of workers performing jobs within the robot's restricted space.
 - 3) Maintaining worker position and stance
Position and stance that enables the worker to confirm normal robot operation and to take immediate refuge if a malfunction occurs.
 - 4) Implementation of measures for noise prevention
 - 5) Signaling methods for workers of related equipment
 - 6) Types of malfunctions and how to distinguish them

Please ensure "working regulations" are appropriate to the robot type, the place of installation and to the content of the work.

Be sure to consult the opinions of related workers, engineers at the equipment manufacturer and that of a labor safety consultant when creating these "working regulations".

4.4 Display of Operation Panel

To prevent anyone other than the worker from accessing the start switch or the changeover switch by accident during operation, display something to indicate it is in operation on the operation panel or teach pendant. Take any other steps as appropriate, such as locking the cover.

4.5 Safety Installation and Operation of the Hand (end-effector)

When install or operate the hand(end-effector), make sure that power loss, changes of air or power supply do not cause hazardous conditions. Also, please be aware that residual energy might exist inside the device.

4.6 Ensuring Safety of Workers Performing Jobs Within the Robot's Restricted Space

When performing jobs within the robot's restricted space, take any of the following steps to ensure that robot operation can be stopped immediately upon a malfunction.

- (1) Ensure an overseer is placed in a position outside the robot's restricted space and one in which he/she can see all robot movements, and that he/she is devoted solely to that task.
 - ① An emergency stop device should be activated immediately upon a malfunction.
 - ② Do not permit anyone other than the worker engaged for that job to enter the robot's restricted space.
- (2) Ensure a worker within the robot's restricted space carries the portable emergency stop switch so he/she can press it (the emergency button on the teach pendant) immediately if it should be necessary to do so.

4.7 Inspections Before Commencing Work Such as Teaching

Before starting work such as teaching, inspect the following items, carry out any repairs immediately upon detection of a malfunction and perform any other necessary measures.

- (1) Check for any damage to the sheath or cover of the external wiring or to the external devices.
- (2) Check that the robot is functioning normally or not (any unusual noise or vibration during operation).
- (3) Check the functioning of the emergency stop device.
- (4) Check there is no leakage of air or oil from any pipes.
- (5) Check there are no obstructive objects in or near the robot's restricted space.
- (6) In case of emergencies, worker shall carry emergency stop switches (for teach pendant and mini-pendant, emergency stop buttons) to be able to press immediately.
- (7) Make sure that no one exists inside the safety fence except for who engages operation.

4.8 Release of Residual Air Pressure

Before disassembling or replacing pneumatic parts, first release any residual air pressure in the drive cylinder.

4.9 Initial Test after Installation or Parts Replacement

After installation or parts replacement, make sure to perform the initial test. If all axis can be operated in manual mode, the installation or parts replacement is succeeded.

4.10 Precautions for Test Runs

Whenever possible, have the worker stay outside of the robot's restricted space when performing test runs.

Perform initial test and periodical check-up to confirm whether the protective measure is effective.

Protective measure includes emergency stop switches, signal related to the safeguarded space (auto enable signal, protective stop signal), mechanical stopper and others.

4.11 Precautions for Automatic Operation

(1) At start-up

Before selecting the automatic mode, ensure that all safety protective functions are working.

Stay out of the safeguarded space with a safety fence when starting the robot; in particular, take extra caution in Internal automatic operation.

Before starting the robot, check the following items as well as setting the signals to be used and perform signaling practice with all related workers.

- 1) Check that there is no one inside the safeguarded space (with a safety fence).
- 2) Check that the teach pendant and tools are in their designated places.
- 3) Check that no lamps indicating a malfunction on the robot or related equipment are lit.

(2) Check that the display lamp indicating automatic operation is lit during automatic operation.

(3) Steps to be taken when a malfunction occurs

Stop the robot's operation by activating the emergency stop device when it is necessary to enter the safeguarded space with a safety fence to perform emergency maintenance in the case of malfunction of the robots or related equipment.

Take any necessary steps such as posting a notice on the start switch to indicate work is in progress to prevent anyone from accessing the robot.

4.12 Precaution for Power Switch

Make sure to turn the power switch off during installation, assembling (electric wiring, mounting tool or end-effector, air piping), daily maintenance, repair, parts replacement.

A power switch of the controller is the second circuit breaker. Residual current exists inside of the controller after turn off the switch. Make sure to shutdown the power supply to the controller by pulling off the power connector or turning off the customer-prepared breaker before this operation.

Also, make sure to lockout to prevent turning on power supply by other workers.

4.13 Precautions in Cleaning

Make sure to turn off the power breaker of the installation before cleaning of the robot, cables and other parts.

4.14 Safety Storage of Pendants

To prevent misuse, please store unused teach pendant or mini-pendant in a controlled area.

4.15 Precautions in Repairs

- (1) Do not perform repairs outside of the designated range.
- (2) Under no circumstances should the interlock mechanism be removed.
- (3) When opening the robot controller's cover for battery replacement or any other reasons, always turn the robot controller power off and disconnect the power cable.
- (4) Use only spare tools specified in this manual.

4.16 Action During Emergencies and Malfunctions

Decide on actions to be taken by personnel when emergencies or malfunctions occur, and train them in advance.

In case of being caught by the robot, axis can be moved by hand to escape.

In addition, when the axis do not move due to the brake, use the brake release unit or the teach pendant to release the brake.

Regarding release of the brake, see the INSTALLATION & MAINTENANCE GUIDE for each robot.

To prevent injury, please be careful not to apply too much force when pressing the axis. especially for axis which does not equip the brake.

4.17 Mechanical Stoppers

When the robot has collided with a mechanical stopper, contact us for inspection and repairs before using the robot because the robot may be damaged.

5. Daily and Periodical Inspections

- (1) Be sure to perform daily and periodical inspections. Before starting jobs, always check that there is no problem with the robot and related equipment. If any problems are found, take any necessary measures to correct them.
- (2) When carrying out periodical inspections or any repairs, maintain records and keep them for at least 3 years.

6. Managing robot data

- (1) After finishing teaching or making any changes, always back up data such as programs with off-line software (WINCAPSIII). Making back-ups will help you recover if data stored in the robot controller is lost because the life of the back-up battery has expired.
- (2) Clearly indicate for which robot the back-ups were made to prevent the data from being loaded into the wrong robot controller.

7. Safety Codes

The safety standards relating to robot systems are listed below. As well as observing the safety precautions given in this manual, ensure compliance with all local and national safety and electrical codes for the installation and operation of the robot system.

Standards	Title
ANSI/RIA R15.06-1999	Industrial Robots and Robot Systems--Safety Requirements
ANSI/UL1740: 1998	Safety for Robots and Robotic Equipment
CAN/CSA Z434-03	Industrial Robots and Robot Systems--General Safety Requirements
ISO10218-1: 2011	Robots and robotic devices--Safety requirements for industrial robots--Part 1: Robots
ISO10218-2: 2011	Robots and robotic devices--Safety requirements for industrial robots--Part 2: Robot systems and integration
NFPA79: 2012	Electrical Standard for Industrial Machinery

8. Battery Recycling

DENSO Robot uses lithium batteries.

Discard batteries according to your local and national recycling law.



お問い合わせ先

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