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NACHI

FD20 CONTROLLER INSTRUCTION MANUAL SETUP

4th edition

- Before attempting to operate the robot, please read through this operating manual carefully, and comply with all the safety-related items and instructions in the text.
- The installation, operation and maintenance of this robot should be undertaken only by those individuals who have attended one of our robot course.
- When using this robot, observe the low related with industrial robot and with safety issues in each country.
- This operating manual must be given without fail to the individual who will be actually operating the robot.
- Please direct any queries about parts of this operating manual which may not be completely clear or any inquiries concerning the after-sale service of this robot to any of the service centers listed on the back cover.

NACHI-FUJIKOSHI CORP.

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Chapter 1 Point on Safety

This chapter explains the safety precautions to be observed when handling the robot system. This section describes general precautions and procedures on safety but does not show all of the safety measures. Therefore, it is necessary for customers to prepare yourself a safety control standard including your own operational regulations in accordance with the actual working environment and to conduct safety control in order to secure the operators' safety.

1.1 For safely use of the robot system

Before using a robot system, read this manual and all other attached documents carefully, and make sure you understand the correct information on the equipment and safety precautions.

1.1.1 Symbols used in all the instruction manuals

Safety information to prevent the injury to personnel and/or damage to equipment is classified by the following symbols.

Cases where a mistake made in handling is likely to cause the user to be exposed to the danger of death or serious injury and where the degree of the urgency (imminence) of the warning given for the danger to occur is at the high end of the scale (including high-level danger).

Cases where a mistake made in handling is likely to cause the user to be exposed to the danger of death or serious injury.

Cases where a mistake made in handling is likely to cause the user to be exposed to the danger of minor injuries or of property damage only.

The following symbols are also used for important checkpoints:

A particularly important checkpoint is shown.

Useful information is shown.

Info for deeper understanding for the main text is shown.

1.1.2 General precautions for safe use of the robot system

This section describes general precautions to prevent the injury to personnel and/or damage to equipment.

Conditions when a disaster occurred while a robot system was used are shown in Table 1.1.1.

Table 1.1.1 Conditions when a disaster occurred

Example 1	Auto operation started without confirming there were no people inside the manipulator's work area.
Example 2	A person entered the manipulator's work area which was in auto operation mode and the manipulator started unexpectedly.
Example 3	A person paid attention to one manipulator forgetting another one was operating within reach of them.
Example 4	Sudden change of movement from low speed to high speed
Example 5	Manipulation by another operator without permission
Example 6	The manipulator is operated by different program because of program mistakes or faulty peripheral equipment.
Example 7	Work at a stop of a manipulator waiting for interlocking is released suddenly, and then the manipulator started to move unexpectedly.

Thus, a disaster by the robot system is caused by unsafe acts and unsafe conditions of an operator. Therefore, it is important to remove unsafe acts and unsafe conditions by an operator in order to prevent a disaster.

The followings are general precautions to prevent a disaster.
Be sure to obey the following precautions when you use a robot system,

Do not come close near the manipulator.
Fatal or serious injury may result if a person is hit or caught by a manipulator due to unexpected motion.

Only perform work within the manipulator‘s work area after turning off the primary power supply and circuit breaker on the robot controller.

Make sure no one exists in the manipulator's work area when the power is turned on.

Operators must wear helmet, safety shoes and overalls.

In case that inspection or maintenance work has to be done with a robot controller's power on, a watcher (third person) must be present outside the guarding fence and watch the work at any time while being ready to press an emergency stop button immediately.

In case that inspection or maintenance work has to be done with a robot controller's power on, allocate, confirm and know an escape route prior to beginning of the work.

Do not alter or remodel our products.
You may get injured or have your equipment damaged because of fire, failure or malfunction caused by altering or remodeling the product.
The warranty does not cover any altered or remodeled products.

While robot controller is power ON, do not touch any parts in the robot controller.
Because protection against electric shock due to charging live part, wait 5 minutes after turning off the mains power before working inside the controller.

While robot controller is power ON, do not detach or attach any cables and their connectors.
Failure to adhere to the precautions may cause the robot and/or controller to fail, break or operate in error.

In order to follow above precautions, it is necessary to thoroughly understand the cautions described hereafter and observe them precisely.

1.1.3 Safety Measures on manipulator

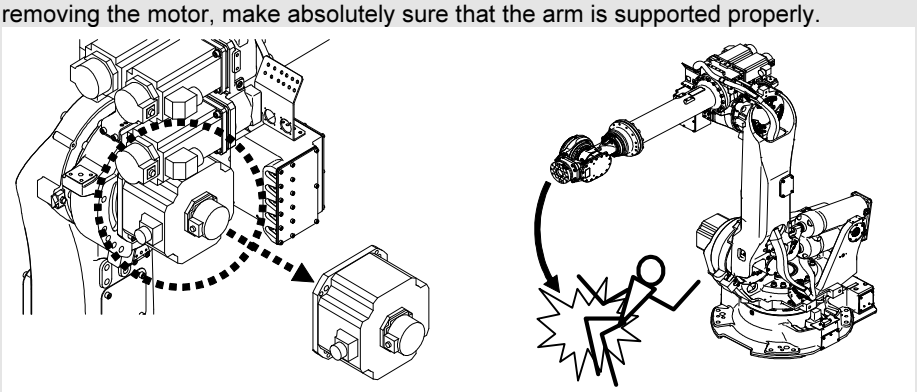
The manipulator is of such design that no unnecessary protrusions or sharp corners exist. It is made of suitable material for use in the environment for which it was designed and has fail-safe construction to minimize damage or accidents during operation. The manipulator maintains a good level of safety because various safety functions exist; such as those to detect incorrect operation and stop the manipulator, or to make emergency stops, interlocking with peripheral equipment, when either device threatens to damage the other.

WARNING

The manipulator is of multi-articular arm construction, thus each articular angle varies all the time with manipulator movement. Take care and avoid getting pinched in various articulations, especially when teaching. Pay careful attention to the stopper blocks mounted on the moving tip of the articulations. The arm may fall under its own weight when motors are removed or brakes are released. Therefore take action to prevent dropping and check that conditions are safe before starting work.

WARNING

Unless the arm is supported properly, it will drop if the motor is removed. Before removing the motor, make absolutely sure that the arm is supported properly.



Do not rely on the positioning pin alone to secure the arm since it may be inserted incorrectly or inserted only half way in. Use a wooden block, sling or other means to support the arm properly before attempting to remove the motor. The manipulator arm must NOT be supported by a person's hand.

CAUTION

Never remove or disassemble a balancer as it is compressed under great pressure. Removal is a very dangerous act.

CAUTION

Use specified bolt sizes and number. Be sure to tighten them to specified torque with a torque wrench when fitting equipment onto the end effector flange or arms.
Use clean rust-free bolts. Otherwise bolts may loosen during operation leading to serious accidents and injuries.

CAUTION

When fabricating the end effector, set its weight and static load moment within the range of the permissible load levels of the manipulator wrist.

CAUTION

Provide a failsafe construction which will ensure that the work gripped will not be released or scattered even when the power or air supply to the end effector is cut off. Also remove any sharp edges or protrusions in its construction to prevent injury to personnel and damage to property.

In order to operate the manipulator, services such as electric power, plant air and cooling water for welding should be supplied. However, non-specified services may affect the manipulator performance and cause abnormal behavior, errors or damage, resulting in a dangerous situation. Never use unspecified resources.

It is not possible to eliminate electromagnetic interference completely using the technology available today although the extent of its elimination depends on the type and strength of the interference concerned. In terms of what action to take while the manipulator is operating and while the power is on, follow the precautions to be observed during operation. In some cases, electromagnetic waves, other forms of noise or defective circuit boards may erase the recorded programs. As a safeguard, make backups of the programs, constants, etc. on a Compact Flash card or other media.

1.1.4 Safety measures in teaching and inspection

Manipulator operators must only be those who have completed specified training and are fully aware of safety and functions of the manipulators. Accidents may occur due to mishandling of the manipulator during operation by those who do not know the correct procedures well.

In case that inspection or maintenance work has to be done with a robot controller's power on, a watcher (third person) must be present outside the guarding fence and watch the work at any time while being ready to press an emergency stop button immediately.

Wear protective gear such as a **helmet** and **safety boots** when operating the robot or entering its work area.

Keep the robot's key switch and a safety plug for changing to Auto operation with you when entering the manipulator's work area so other people can not change the switch to Auto operation accidentally. If the key is left in the switch other operators may accidentally start Auto operation leading to serious accidents.

Display (attach) a sign showing **"Teaching Under Way"** on the operation panel when teaching. Other operators are required to notice this fact. If not, they may start the Auto operation, resulting in serious or fatal accidents.

When **a number of operators are involved in the teaching of a manipulator**, the operator holding the teach pendant is in charge and must give commands and the others must follow.
Commands given by numerous operators may invite incorrect manipulation, leading to accidents.

CAUTION

Consider methods to communicate with other operators such as **hand signals** when conversation takes place among a number of operators positioned separately, in a large system (plant) for example. Accidents are likely to occur due to misinterpreted intentions in a noisy site.

Examples of hand signals for industrial robot operation

1.Switch ON  Act like pressing a switch.	2.Switch OFF  Raise the right hand high and then swing it left and right clearly.
3.OK ? (Confirmation)  Raise the right hand high with palm facing forward.	4.OK !  Raise the right hand high with palm facing forward and thumb and index finger creating a circle.
5.Wait !  Face the right hand palm forward with its arm extended horizontally.	6.Go away !  Extend the right hand horizontally and swing it to the left.

CAUTION

Keep a safe place (escape route) in mind at all times to quickly escape in an emergency.

WARNING

Pay attention to the manipulator's movement at all times and never work with your back toward the manipulator. An operator may not notice the start of a manipulator if he/she is not facing it resulting in an accident.

WARNING

Press the emergency stop button immediately if you notice any abnormality. Make this practice very clear to every operator.
A sudden movement may be imminent if you are watching something abnormal.

CAUTION

Prepare an appropriate **working code and checklist** for start up of the manipulator, how to operate it and what actions to take in an emergency. Proceed with operation according to the working code. Accidents are likely to occur due to forgetfulness and error of operators if relying on memory alone.

Proceed with work with **the robot's power off** when operation or manipulation of the manipulator is not necessary. It can never run with its power off.

When teaching, **always check the program number and step number** before operating the manipulator. Editing of incorrect programs or steps may cause accidents.

Protect completed programs from accidental editing by using **the memory protect function.**
(The memory protect function disabling the editing of various programs and constants is available on the robot controller.)

Check manipulator movement at a low speed using the check go/back function and the velocity override function after completing teaching. Accidents due to collision are likely to occur if a program containing a mistake is checked at 100% full speed in the playback mode.

Clean the area within the guarding fence and check that tools, etc. are not left there after teaching is complete. A workplace fouled with oil or grease and tools is a hazardous place and may lead to an accident due to stumbling. "**Cleaning the workplace**" is a step toward safety.

Don’t turn on primary power for five seconds after turning off primary power.

LOCKOUT AND TAG OUT EQUIPMENT, BEFORE SERVICING.

Be absolutely sure NOT to expose the controller inside to direct sunlight, a searchlight or other strong lights before turning on the primary power supply while the controller door is left open to enable maintenance or other work to be performed.
Failure to adhere to the precautions may cause the manipulator and/or controller to fail or operate in error.

WARNING

Handling precautions of USB memory

1. Do not disassemble, alter and repair the USB memory by yourself. There is a danger of a fire and / or electric shock.
2. Read instruction manuals prior to use of the USB memory and obey the precautions.
3. Do not use this product with wet hands. There is a danger of an electric shock and / or a malfunction.
4. Prior to operating a USB memory, discharge static electricity charged on a worker. Antistatic wrist band is effective. To touch a USB memory without countermeasures may cause breakdown.
5. If smoke or badly smelling from the USB memory occurs, immediately shut down the primary power and circuit breaker on the controller. After that, contact our service center. If the damaged USB memory is continued to use, there is a danger of an electric shock and / or fire.
6. Do not use the USB memory in a place where the water is used or with high humidity. There is a danger of electric shock, fire and / or malfunction.
7. In case that a foreign object is mixed in the USB memory, shut down the primary power supply and circuit breaker on the controller. After that, contact our service center. If the damaged USB memory is continued to use, there is a danger of an electric shock and / or fire.
8. Do not drop or give any shock to the USB memory. The USB memory is precision equipment so that the malfunction may occur.
9. In case that dirt or dust adheres to the connector of USB memory, remove them with dry and clean cloth. Use of it under dirty conditions causes the malfunction.
10. Do not wipe the USB memory with organic solvent such as thinner or benzine, etc.
11. Remove the dirt on the USB memory with dry and clean cloth. If the heavy grime is adhered on the USB memory, let a little neutral detergent soak in the clean wet cloth, squeeze it tightly and wipe it.

1.1.5 Safety measures in test run

In the test run, design errors, teaching errors or manufacturing errors may exist in addition to probable errors in the teaching program, jigs, sequence, etc. Therefore the test run requires greater safety consciousness. Perform a test run paying attention to the following points;

WARNING

Check all buttons to stop the robot system, such as the emergency stop button, other stop buttons, and the enable switch and that their signals work well. Then check the functions associated with detection of abnormalities.
Confirmation of "stop" is most important. Accident or injury may result due to the failure of a stop button or signal in an emergency.

CAUTION

When performing the test run, start the robot system up at a low speed (about 5% to 10%), with the velocity override function, **to check the movement**. Repeat these about 2 to 3 cycles. Correct any errors, if any, at once.
Then gradually increase the speed (50% → 70% → 100%) and repeat 2 to 3 cycles at each speed to confirm the movement.
It is difficult to stop a robot system, when an error occurs, before it causes damage if checking is started at a full speed.

DANGER

DO NOT enter a guarding fence at any speed during Automatic operation.

1.1.6 Safety measures in auto operation

WARNING

Install a guarding fence so that no one enters the manipulator’s work area during Automatic operation.

Clean the workplace and keep everything in order at the beginning and end of work.
If the workplace is littered with various items, accidents, such as tripping, may occur.

Ensure **a daily inspection** according to the specified **check list** is done before startup.
By discovering abnormalities in advance, accidents can be avoided.
(Refer to Maintenance Manual for the daily inspection items.)

An "**OFF LIMITS**" sign should be displayed at all entrances of the guarding fence and all employees made aware of this rule. If not, they may enter the guarding fence thinking that the manipulator is inoperable.

Always **confirm there is no one within the guarding fence** before starting auto operation.
Accidents caused by neglecting to confirm a person's presence are the most typical.

Start auto operation after confirming the program number, step number, mode and startup select are all ready for **auto operation**. If the manipulator is started with an incorrect program or step selected, unexpected incorrect movement may occur resulting in an accident.

Before starting automatic operation, move the manipulator to the step in which automatic operation can be started using Check Go or Check Back. If the manipulator is not moved to the requested step number, unexpected incorrect movement may occur directly after automatic operation is started which may result in an accident.

Before Start up, make sure **the emergency stop button can be pressed immediately**.
This is vital in dealing with unexpected occurrences.

Operators should be familiarized with **the manipulator's movement path, operating behavior, running sound, etc**. so that abnormalities can be detected. Failures may be avoided by recognizing abnormal behavior as abnormalities may indicate an imminent system failure. In order to detect these operators need to be fully aware of the normal status of operation.

Make an emergency stop immediately if any abnormal behavior is observed and report the incident to superiors or the person in charge of maintenance, and take appropriate action. The "It's moving. That's OK" attitude can cause not only a stop in production due to failure but serious injury.

When verifying operation after remedial measures have been taken to deal with the occurrence of fault, refrain from conducting any operations—such as conducting low-speed playback to verify operation—while an operator is still inside the safety fence until it is confirmed that the fault has indeed been remedied. What will happen in this kind of situation cannot be reliably predicted so other fault may occur or unforeseen accidents may result.

1.1.7 Brake Positive Release

If the operators are pinched in the manipulator, brake positive release is possible to operate it manually. For details of the procedures, refer to “Controller maintenance”.

1.1.8 Movement, alienation and selling of robot system

Hand over all manuals and documents received when purchasing the robot system to the new owner when moving, alienating or selling a robot system. In particular, if the robot system is to be moved, transferred or sold overseas, the user is responsible for preparing and supplying the instruction manuals in the appropriate language, amending the language used for the labels and displays and complying with the laws of the country concerned. Accidents may occur if the new robot system owner (operator) operates the robot system incorrectly or performs unsafe work tasks due to not receiving and reading the Operating Instructions.

When the robot system is moved, transferred or sold (either in the country or overseas) by the user, whatever was agreed upon at the time of the robot system's initial sale inclusive of the safety-related items is not transferable to the new owner unless a special agreement has been concluded.
The user must conclude a new agreement with the new owner.

1.1.9 Storage of robot system

For storing a robot system, following ambient conditions shall be met.

1) Storage temperature：0℃～50℃
（For long-term storage, 25℃±10℃ are recommended to maintain the reliability.）
2) Storage humidity：20%～85%（Non condensing）
3) There shall be little dirt, dust, lampblack, and water.
4) There shall be no flammable or corrosive liquids and gases.
5) The robot system must not receive any shocks or vibrations.

1.1.10 Disposition of Robot system

Do not disassemble, heat or burn batteries used in the controller and manipulator as they may catch fire, burst or burn.

Do not disassemble the controller in detail smaller than PCBs or units. Sharp edges or electric wire of small disassembled pieces may cause injury.

Do not disassemble wire harnesses or robot system external wiring further than disconnecting wiring from connectors or terminal blocks. Disassembled pieces, eg. Semiconductors etc., may cause injury to hands or eyes.

Use extreme care when scrapping so as to avoid accidents and injury such as pinching hands or fingers.

Discard scrapped items safely to avoid injury.

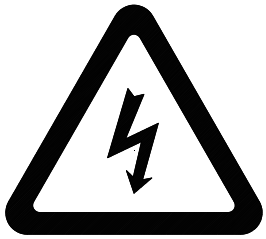
Cautions about Batteries

1. The replacement of the batteries should be done in principle by a trained technician.
2. Do not use the batteries except the specified use.
3. DO NOT recharge the battery.
4. Do not heat, disassemble, deform, solder and dispose the battery in fire.
5. Do not drop, hit, throw, or give any shock to the battery.
6. Do not put either plus terminal and the minus one oppositely.
7. Do not connect (+) and (-) of the battery.
8. Keep batteries out of reach of babies and little children. If battery is swallowed, immediately consult a doctor.
9. A leaking or badly smelling battery should be discarded immediately. The leaking electrolyte may corrode metal parts.
10. If the liquid of the batteries touches the eyes, the eyes may be injured. Do not rub the eyes but flush the eyes generously with clean water such as city tap-water and then receive medical treatment without delay.
11. Remove the used batteries immediately.
12. At disposal of the batteries, insulate the terminal parts with tape or the like.
13. Dispose of the used battery according to your domestic regulations.

Dispose of a USB memory according to your domestic regulations.

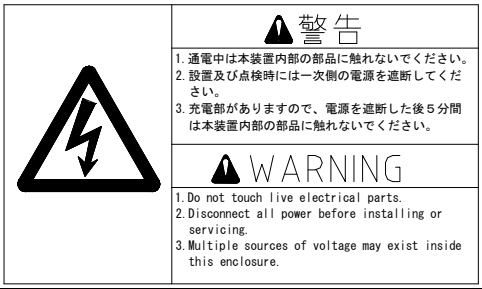
1.1.11 Labels and marks on manipulator and controller

Supplementary explanation is made below concerning the labels and warning plates attached to the manipulator and the controller.

	This label is pasted around the primary power supply inlet and the transformer case cover of the robot controller, and the connectors of control cables of the manipulator. This mark indicates the power supply part.

In the controller, a primary power voltage (AC 200V to AC 480V) exists, which may cause serious electrocution. Turn off the power at both the controller breaker and the power distribution panel when doing maintenance.

Motor power and detector unit power is supplied to connectors and terminal blocks under various connector covers on the manipulator mark.
Do not touch connectors or terminal blocks directly or indirectly with conductive items with mains power supplied, as electrocution may occur. If connectors or terminal blocks are removed with mains power on, electric shock or malfunction of the manipulator may result. Turn off mains power on the controller when performing any maintenance.

 or 	This label indicates a high voltage. Use caution when touching units carrying this label. Electrically charged parts in the controller exist even after the mains power is turned off. Therefore it is very dangerous (i.e. electric shock) to touch them too soon after turning off the mains power.

Wait 5 minutes after turning off the mains power before working inside the controller.
Do not work with wet hands otherwise electrocution may result.
If parts get wet, it may lead to a malfunction or failure.

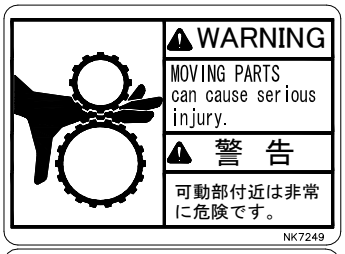
CAUTION

Replace units and/or parts according to procedures given in the instruction manuals.
Incorrect removal and installation may result in a malfunction, failure or accident.

This mark indicates hot parts on the manipulator.

CAUTION

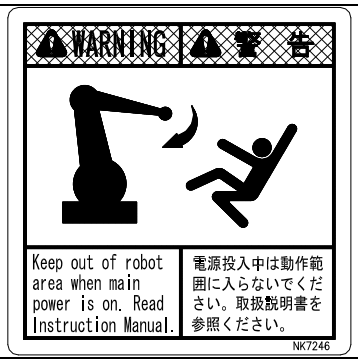
Check that the part bearing this mark is not hot before touching it. Carelessly touching labeled hot parts may result in serious burns.



These marks indicate an area where operators may get caught by the manipulator.

CAUTION

Places bearing this mark should never be touched.
Brakes can be released not only during teaching but also while the motors are off.
Take adequate steps to prevent your hands or other parts of your body from being pinched when these areas are touched during maintenance work, etc.



This mark indicates the warning of the manipulator's work area.

WARNING

Do not enter inside the manipulator's **work area** while the power is still on.
Approaching the manipulator while it is moving may result in fatal bodily injury.

This label indicates that manipulator arms may fall when motors are removed from the manipulator.

CAUTION

Never put yourself under the arm when removing a motor. The arm driven by the motor being removed will drop if not restrained.

WARNING

Unless the arm is supported properly, it will drop if the motor is removed.
Before removing the motor, make absolutely sure that the arm is supported properly.
Do not rely on the positioning pin alone to secure the arm since it may be inserted incorrectly or inserted only half way in. Use a wooden block, sling or other means to support the arm properly before attempting to remove the motor. The manipulator arm must NOT be supported by a person's hand.

This label warns of stored energy. Therefore use caution when disassembling the robot units labeled as such.

WARNING

Never disassemble the parts bearing this mark, even when disassembling the robot system for maintenance. Disassembly of these parts may cause fatal or serious accidents.

	This label indicates that robot arms may fall when stoppers are removed from the robot.

WARNING

Do not operate the robot without mechanical stoppers. Such an operation may cause damage to the peripheral equipment or result serious injury or death.

	This label indicates covers where motor plug is protected. (only for available robot and axis)

WARNING

Do not get on the part where this mark is attached, and work while putting strong power. There is a possibility that the cover and the plug are damaged.

1.2 Precautions for undertaking work inside the manipulator's work area

Ensure that all the personnel involved in working inside the manipulator's work area will wear the following protective gear.

• Do not enter inside the manipulator's work area while the power is still on.
Approaching the manipulator while it is moving may result in fatal bodily injury.

(1) Inside the manipulator's work area, wear a protective helmet at all times.

(2) Inside the manipulator's work area, wear protective goggles with the proper light-shielding glass at all times.

(3) While power is supplied to it, a welder generates magnetic fields around it, and these will adversely affect the operation of a pacemaker.
Therefore, persons fitted with a pacemaker should not approach a welder while it is operating or the welding work area unless they are permitted to do so by their physicians.

(4) Before entering the manipulator's work area or welding work area, be absolutely sure to turn off the incoming power of the robot control unit and welder.

(5) Follow the instructions below to safeguard against the effects of the electromagnetic noise which is generated by the welding arcs.
(a) Install precision instruments, etc. at a distance from the welding arcs.
(b) Use one incoming power supply for the welder and another for the precision instruments, etc.

(6) Since touching a rotating part inadvertently can result in injury, be absolutely sure to follow the instructions below.

• Do not allow your hands, fingers, hair or articles of clothing, etc. to come too close to the rotating parts.
If you bring your hands, fingers, hair or articles of clothing, etc. too close to a rotating part such as the feed roll of a wire feeder, they may become caught by or tangled up in the rotating part, possibly resulting in injury.
If you bring your hands, fingers, hair or articles of clothing, etc. too close to a rotating part of the cooling fan, they may become caught by or tangled up in the rotating part, possibly resulting in injury.

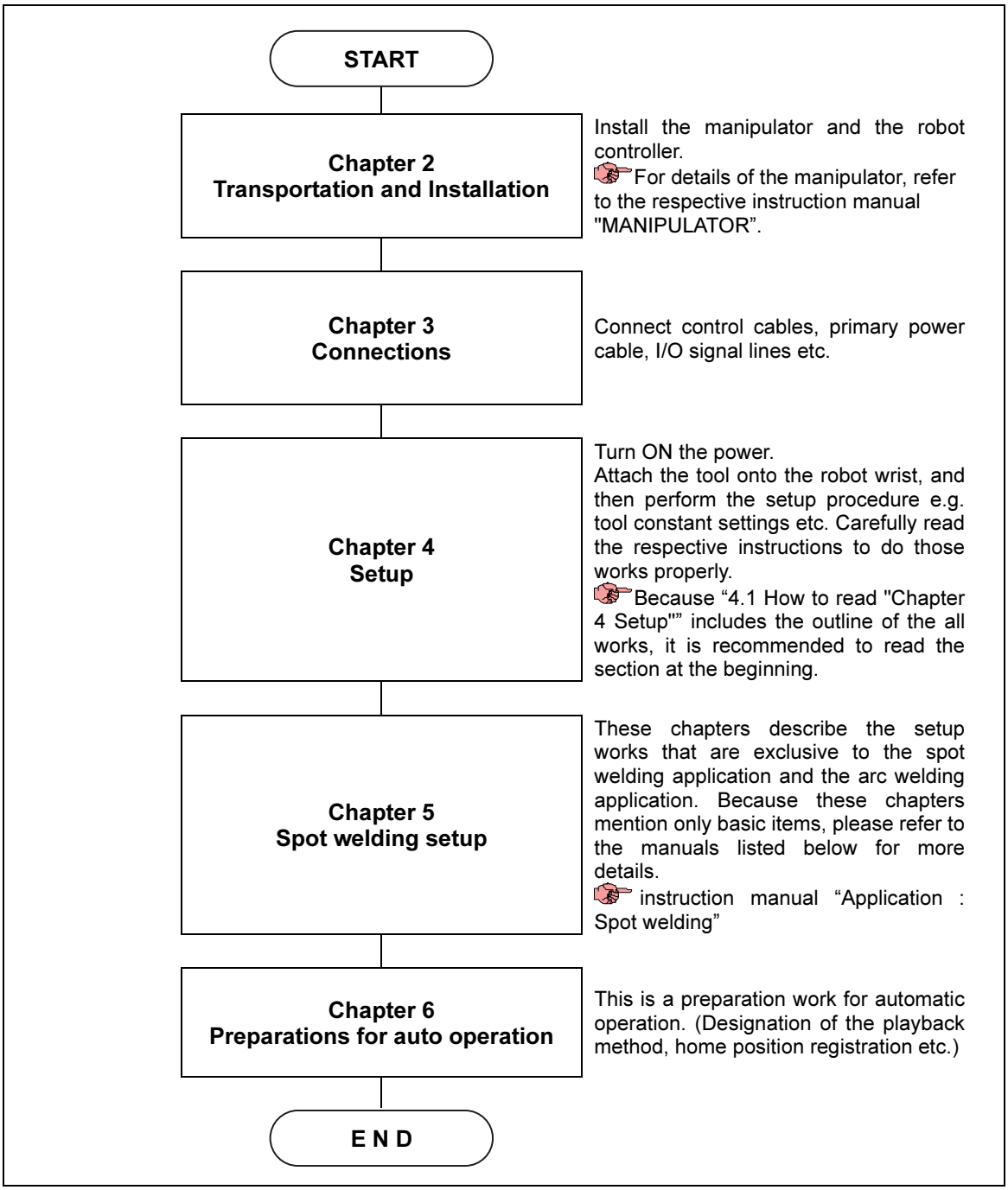
(7) When using with welding specifications, be sure to follow the safety precautions in the welding equipment and welding gun instruction manuals.

Chapter 2 Transportation and Installation

This chapter describes the procedures to be followed in terms of transportation, installation, etc. when the robot is delivered. For further details of transporting and installing the manipulator, refer to the instruction manual “MANIPULATOR" of the particular robot model concerned.

2.1 From the installation work to the teaching work

The outline of the installation work (From the robot installation to the start of the teaching work) is shown as below. Perform this installation work by following the flow chart shown as below.



2.2 Transportation

WARNING

Ensure that the manipulator and robot controller is moved into position by individuals who have acquired the permits or licenses needed for carrying out slinging work, operating cranes, driving forklift trucks, etc.
Adopt handling procedures which are commensurate with the weights described in each instruction manual of the manipulator or robot controller.

WARNING

When hoisting the manipulator and/or the controller, follow the method set forth in this manual or in other instruction manuals. Moving the robot into position using a method not specified by the manufacturer may cause the robot to topple over or fall, which may lead to accidents.

WARNING

Take more than enough care to ensure that the wiring is not damaged during the moving and installation processes. After having positioned the units, take protective measures such as providing protective covers to ensure that the wiring will not be damaged by the operators and other individuals or by the forklift trucks.

2.2.1 Manipulator

Transportation procedure depends on the type of manipulator.
For details, refer to each according instruction manual “MANIPULATOR”.

2.2.2 Controller

WARNING

Transfer the controller to its installation place by use of a crane, a forklift, or a hand lifter. When to transfer it by use of a crane, use eye bolts (2 each). And when to use a forklift or a hand lifter, transfer the controller so that it should not fall down.

WARNING

The weight of the controller is
standard single mechanism : Approx. 65 kg
Confirm the actual mass by the label pasted on the robot controller because the mass may vary under other specifications (e.g. transformer specification).
When working, put on protective gears such as a helmet, safety shoes and so forth, and carry out the work while wearing safe working clothes appropriate for the work.

WARNING

Printed boards and other precision devices are used in the controller; therefore do not give any impact during transfer. When hoisting the controller using a crane, take care that none of the parts on the controller will be damaged by the wires.

CAUTION

Use the wires and shackles which meet the following strength when transporting the robot controller for the standard single manipulator.

Hanging wires
Withstand load : 450 kg or higher / Length : 1.5 m or longer
Shackles
0.9 t or higher / JIS B2801

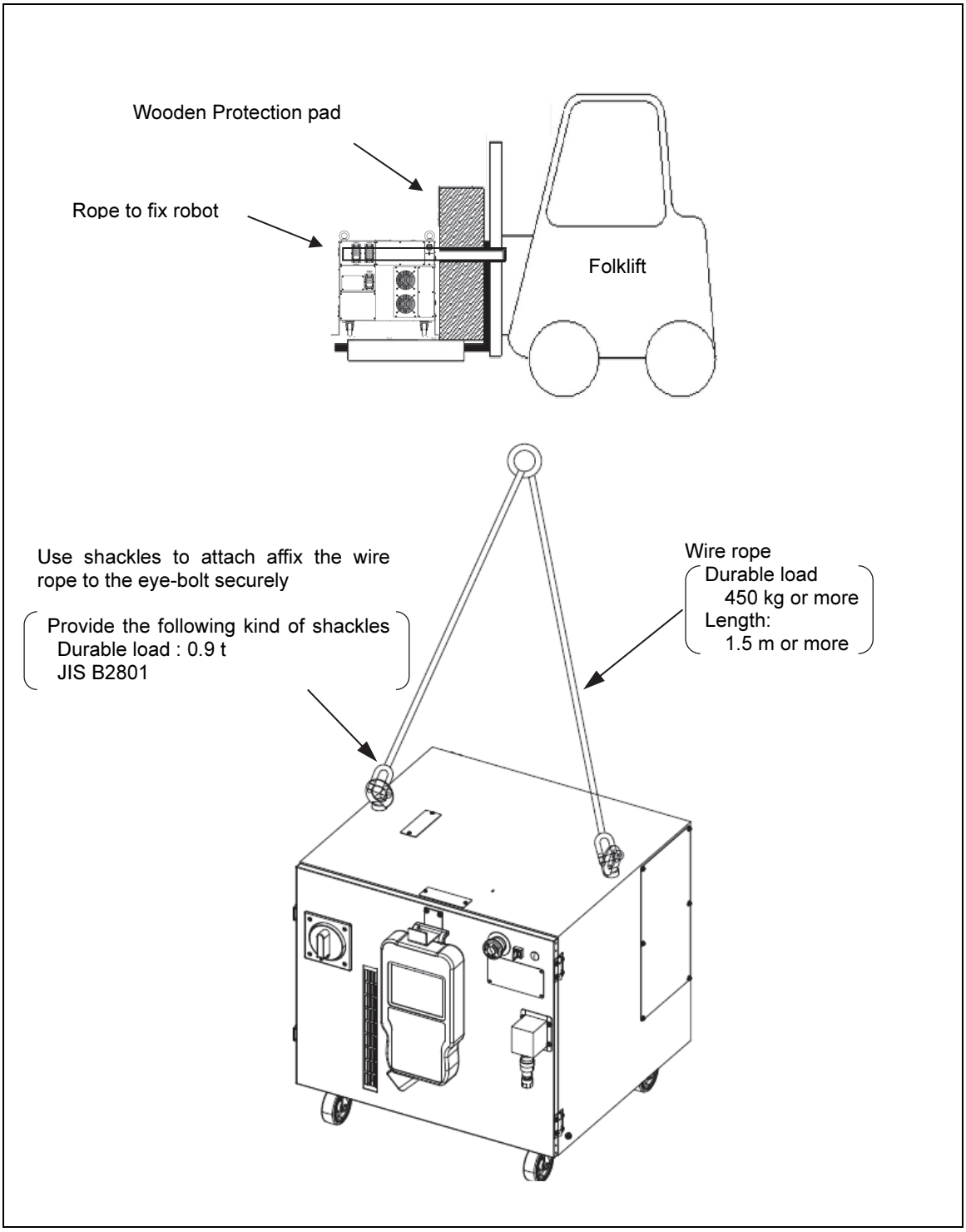


Fig. 2.2.1 Controller transportation method

2.3 Robot Installation

The locations and methods for installing manipulator are critical for maintaining the functions of the robot.

The ambient atmosphere in the installation location affects the lifespan of the mechanisms, but it also matters with safety.

To ensure safety, special attention must be paid to the environmental conditions, the installation method and dimensions of the manipulator and its foundation.

For details, refer to according instruction manual “MANIPULATOR”. Follow all the conditions after reading it carefully.

2.4 Installation of robot controller

2.4.1 Robot controller installation location and the environment

Install the robot controller in a location that satisfies all the following conditions.

(1) A location not exposed to direct sunlight, with an ambient temperature of 0 to 45 degrees Celsius throughout the year.

(2) A location with an ambient relative humidity of 20 to 80% and no condensation.

(3) A location with minimum amounts of dust, dirt, oily vapors, water, etc.

Pollution degree:2

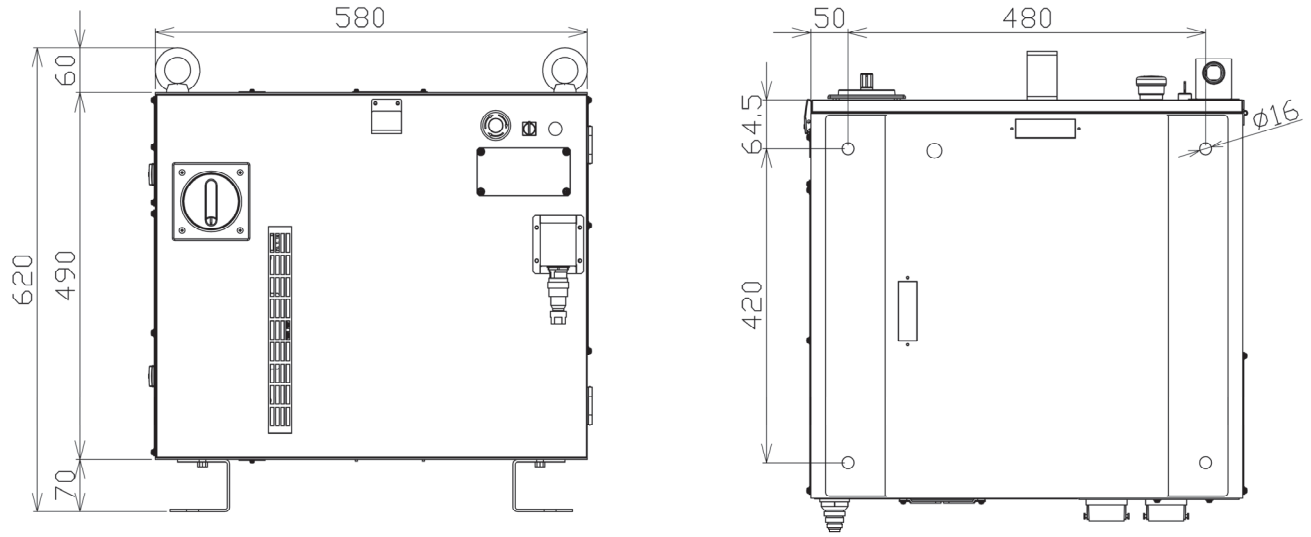
(4) A location with no flammable or corrosive liquids or gases, etc.

(5) A location where the maximum shock or vibration transmitted to the controller by the operation of other machines in the area is 0.5 G (4.9 m/sec^2) or less.

(6) A location with no major sources of electrical noise (plasma, high frequency power sources, etc.).

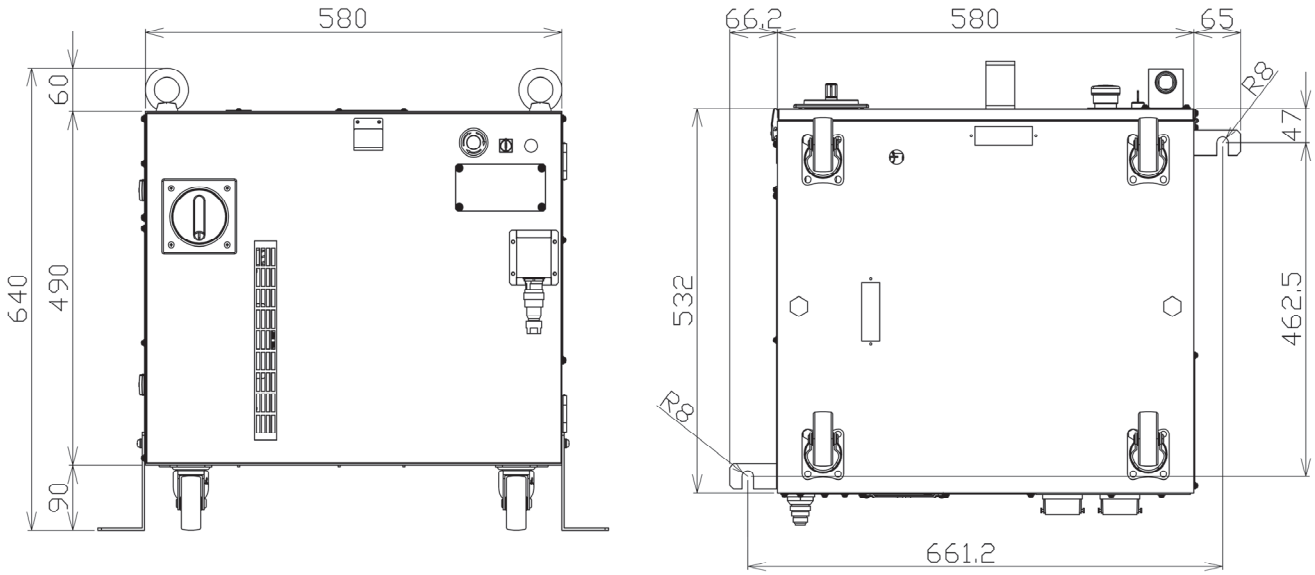
2.4.2 Install dimensions of robot controller

Although the robot controller does not have a movable part like a manipulator, be sure to secure it at its installation location with support channels (option) in order to prevent it from falling when it has been installed at a high place or from toppling over when it has been installed on the floor.



Front view Bottom view

Fig. 2.4.1 Installation dimension of Fixing foot (FD20-OP191-A)



Front view Bottom view

Fig. 2.4.2 Installation dimension of Caster + Metal fittings to prevent tipping over (FD20-OP191-B)

2.4.3 Installation location of robot controller

(1) Be sure to install a guarding fence around manipulators and other devices (positioners, etc.) as shown in the figure below, to prevent people from inadvertently going near them.

DANGER

Be sure to install robot controllers, welders, and peripheral devices such as the operating box, teach pendant and start box (option) outside the guarding fence.

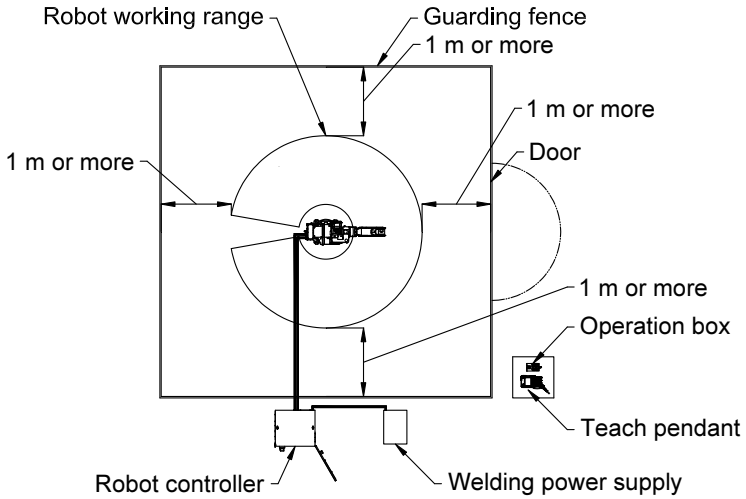


Fig. 2.4.3 Example of guarding fence installation

(2) A robot controller has a through-hole for an external connection cable and cooling fan ventilator on its front side and back side. To install a robot controller, secure a space of at least 200 mm at back space and at least 100 mm at side space by referring to Fig. 2.4.4.

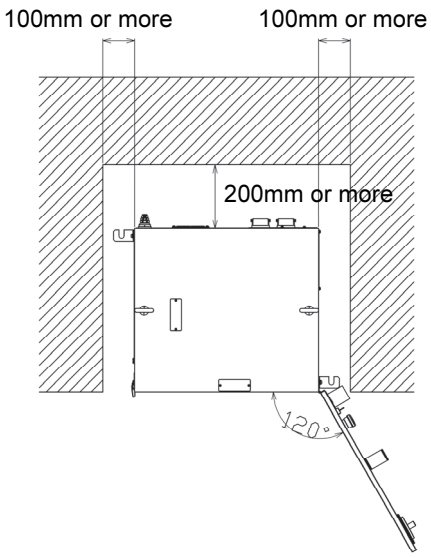


Fig. 2.4.4 Installation of robot controller (Other than high places)

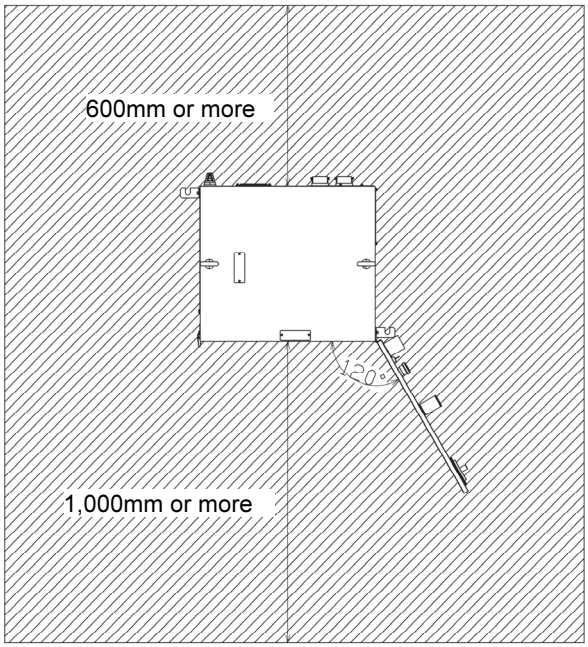


Fig. 2.4.5 Installation of robot controller (High places)

(3) To install a robot controller and welding power supply, etc. on a high place (two or more meters in height) such as a frame base, a foothold as shown on the diagonal line space of Fig 2.4.5. is required so that adjustment and maintenance, etc. work can be performed.

(4) Install the controller so that the height from the working floor to the breaker handle is between 0.6 m to 1.9 m.

2.4.4 Install method of robot controller

When installing the robot controller on the floor, first fit M12 concrete anchors and secure the support channels (option) on the bottom of the controller to the anchor bolts using two M12 lock nuts as shown in Fig. 2.4.6. (Tightening torque: 42.2 N•m (431 kgf•cm)).
If the floor is not strong enough, embed J-shaped anchor bolts in the floor and secure the robot controller as shown in Fig. 2.4.6.

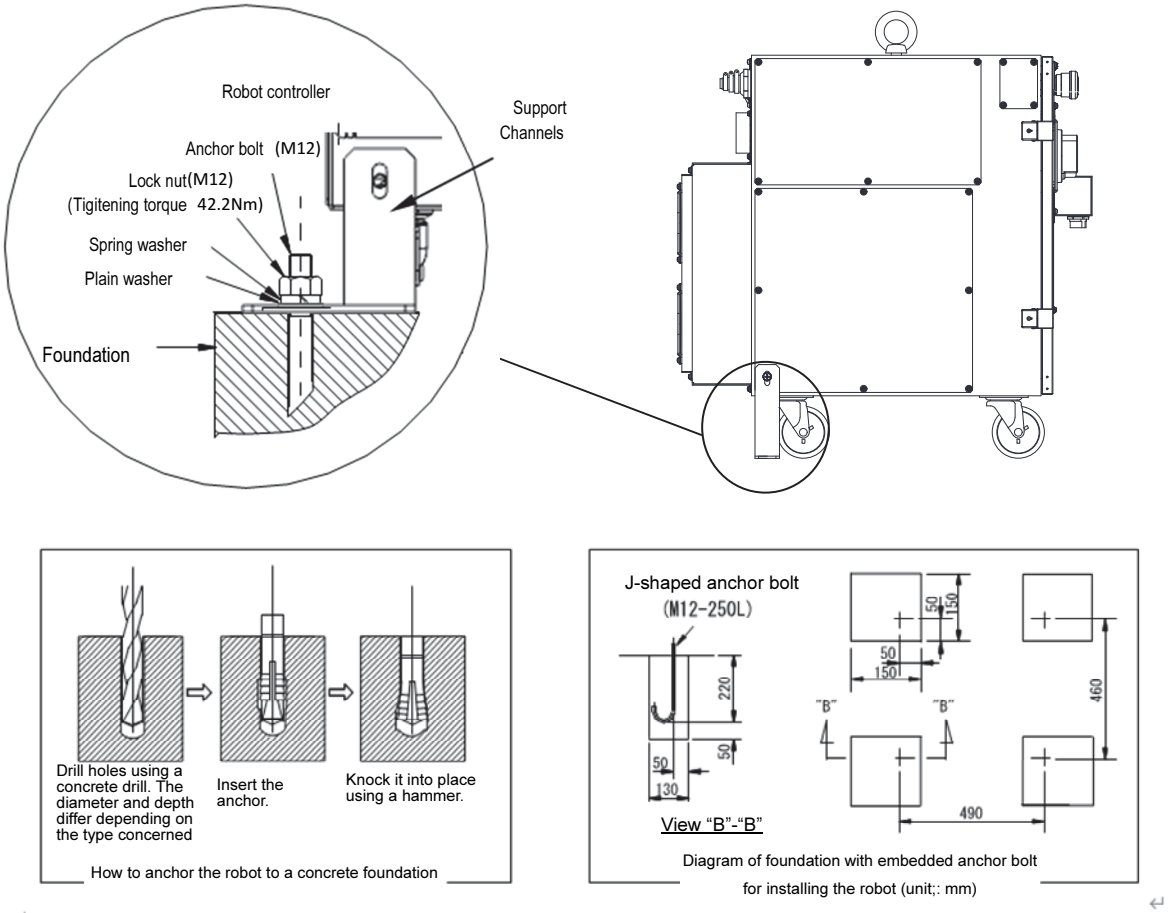


Fig. 2.4.6 Concerning the robot controller installation method

After the robot controller has been installed, lock the breaker of the robot controller. Be absolutely sure that a specially designated person or the person in charge of safety manages the safekeeping of the key for the circuit breaker padlock. (The padlock purchase is necessary by the user.)

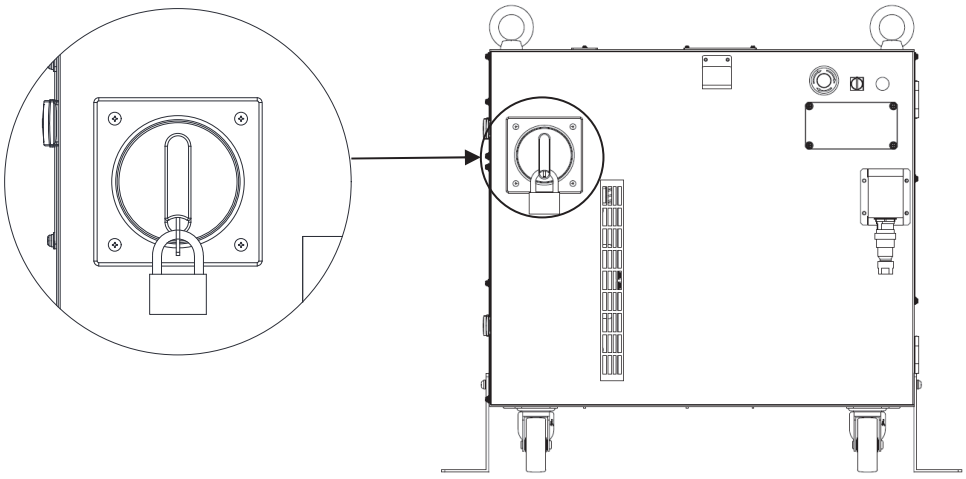


Fig. 2.4.7 Concerning the circuit breaker lock

NOTE

Chapter 3 Connections

This chapter describes how to connect the robot body to the controller, teach pendant and power supply and how to perform the I/O connections with the peripheral devices.

3.1 Summary of Connection Work to Robot Controller

Connection work between the robot controller and various devices is as shown below.

Manipulator connections page 3-3 “Manipulator connection”

Connect the manipulator to the robot controller.

Teach pendant connection page 3-4 “Teach pendant connection”

Connect the teach pendant to the robot controller.

Installation/signal wiring of optional board for physical I/O signals page 3-5 “Installation of Optional board for physical I/O signals”

If required, install an optional board for general purpose physical input/output signals.
The physical I/O can be used to connect your external devices to the robot controller.
To check the specifications of the physical I/O signals, see page 3-30 "Signal specifications of Optional Physical I/O board”.

If you are using the Fieldbus functions (e.g. DeviceNet / PROFINET / CC-Link, etc.), please refer to their respective optional instruction manuals.

Safety-related signal connections page 3-12 "Safety-related signal connections"

Connect safety-related signals such as emergency stop and safety plugs. Always connect these, as they are important safety measures used when abnormalities occur or in emergencies by operators during teaching work.

Primary power supply connection page 3-25 “Primary power supply connection”

Connect the robot controller to your primary power supply equipment.

Although all of these works are important, please pay special attention when performing the ***“Safety-related signal connection”***. If the connections and the operations for those signals are not done correctly, serious injury or death may result.

Be sure to perform electrical connection and disconnection work on the teach pendant, wire harnesses, various cables, signal lines, and optional boards while the power supply to this controller is turned off. If work is performed while the power is on, it may cause a malfunction, in which case the product is out of warranty.

3.2 Precautions for Cable connections

WARNING

Notes on connection

1. Before connecting cables to the robot controller, be sure to turn OFF the switch on the primary switchboard and breaker inside the robot controller, and then check that the voltage is not impressed.
2. Be sure to firmly tighten the joint part (connector and terminal) of cables and hoses.
3. Do not place anything on cables.
4. Do not cross cables each other.
5. Do not lay cables under the welding power supply.
6. Lay out the welding cable and other control cables separately, not binding together.
7. To draw cables in, refer to the directions in the following page and after.
8. After connecting the cables to the robot controller, close the panels completely. If they are not completely closed, dust or dirt will enter the robot controller, which may cause breakdown.

WARNING

Be absolutely sure NOT to expose the controller inside to direct sunlight, a searchlight or other strong lights before turning on the primary power supply while the controller panel is left open to enable maintenance/inspection work to be performed.
Failure to adhere to the precautions may cause the robot and/or controller to fail or operate in error.

WARNING

1. Even if the breaker of this unit is OFF, voltage is still impressed to the primary side of breaker. Before opening the panel for inspection etc., shut off the power source first.
2. There are many high-voltage parts inside the robot controller. Do not touch them. Otherwise, you may get an electric shock. If compelled to open the panel with the power ON in the event of emergency, take special care that you never touch any parts inside.

3.3 Manipulator connection

3.3.1 SRA/MC/MR series connection

WARNING

Electric shock may cause serious injury or death.
Wiring work should be done after turning off the primary power supply and circuit breaker on the controller.

The installation positions (connectors) for the manipulator and robot controller, and wire harnesses (control cable) have the connector names written on. Follow Fig. 3.3.1, and connect each connector and harness correctly with the connectors/harnesses of the same name. There are "male" and "female" cable connectors, which have different key seats. This structure is used to prevent mistaken connections, so forcing connectors together will cause damage. Be careful when making connections.

Connections on manipulator side

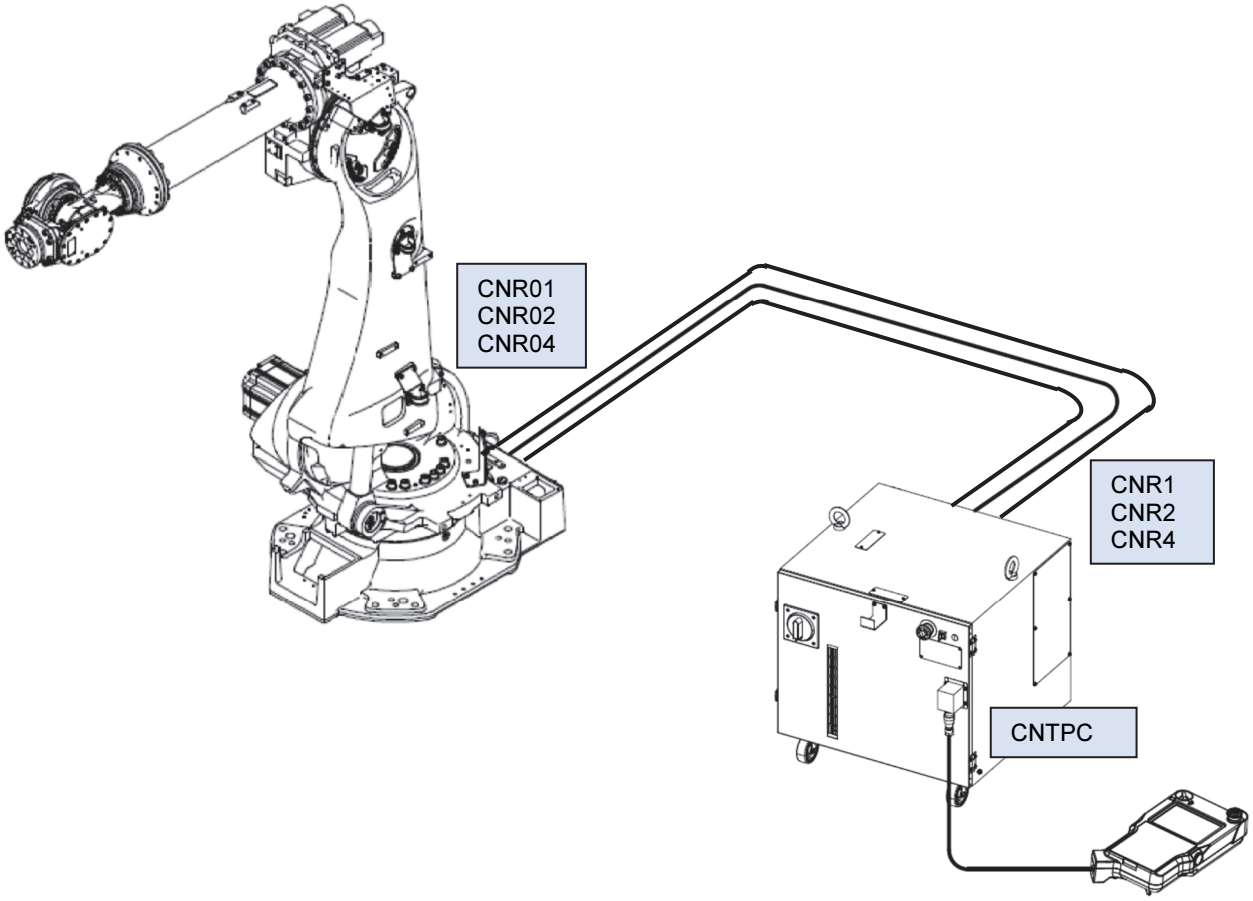


Fig. 3.3.1 Connection of Wire harness

※Number of cables depends on robot model and specifications.

3.4 Teach pendant connection

Described here are the connections for the teach pendant.

WARNING

Please be careful about the following points when handling the teach pendant.
If the touch panel or sheet key is scratched, damaged, deformed or altered, there is the danger that the teach pendant will malfunction or cease to operate.

(1) Use the teach pendant in a location not exposed to airborne substances such as welding fumes, spatters, and slag.

(2) When installing or storing the teach pendant, select a location not exposed to the airborne substances described above.

(3) Do not pierce or scrape the touch panel with sharp or pointed objects, and only press it as hard as necessary.

(4) Do not drop the teach pendant or pressure it with strong force.

(5) Do not wipe the teach pendant with organic solvents such as thinner or benzene. Wipe it gently with a soft cloth or one moistened with detergent or alcohol.

WARNING

Electric shock may cause serious injury or death.
Wiring work should be done after turning off the primary power supply and circuit breaker on the controller.

1 Turn off the primary power supply and circuit breaker on the controller.

2 As shown in Fig. 3.4.1, connect the connector on the teach pendant side to the connector on the controller body side. Push it in until it is locked.

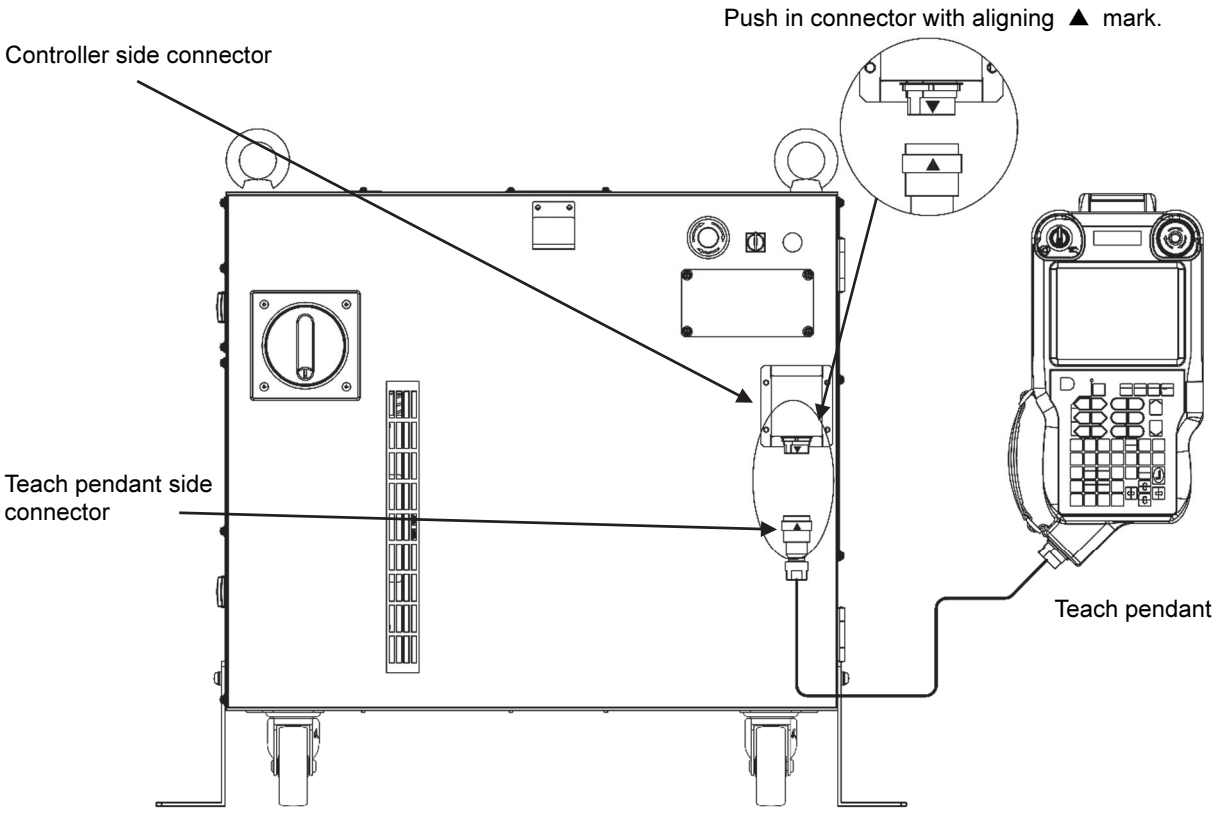


Fig. 3.4.1 Connection of Teach pendant

3.5 Installation of Optional board for physical I/O signals

To connect an external device using physical I/O signals, at least one of the boards/functions shown in Table 3.5.1 is required.
Sections 3.5.1 to 3.5.2 explain an overview of each board and function, and the connection method to the robot controller.

Table 3.5.1 Optional board for physical I/O signals

Board name	Standard / Optional	Reference
I/O board Relay board	Optional	P3-6 “I/O Board Installation”
Mini I/O option	Optional	P3-9 “Mini I/O Option Installation”
Field bus functions	Optional	When using field bus functions such as DeviceNet, refer to each of the related option manual.

3.5.1 I/O Board Installation

3.5.1.1 Overview of the I/O Board

By using the I/O board, I/O points can be increased.
The output of the I/O board is a semiconductor output, shown in Table 3.5.2.
Up to two I/O boards can be installed in one robot controller.
This section describes how to mount the I/O board, and how to connect the I/O cables.

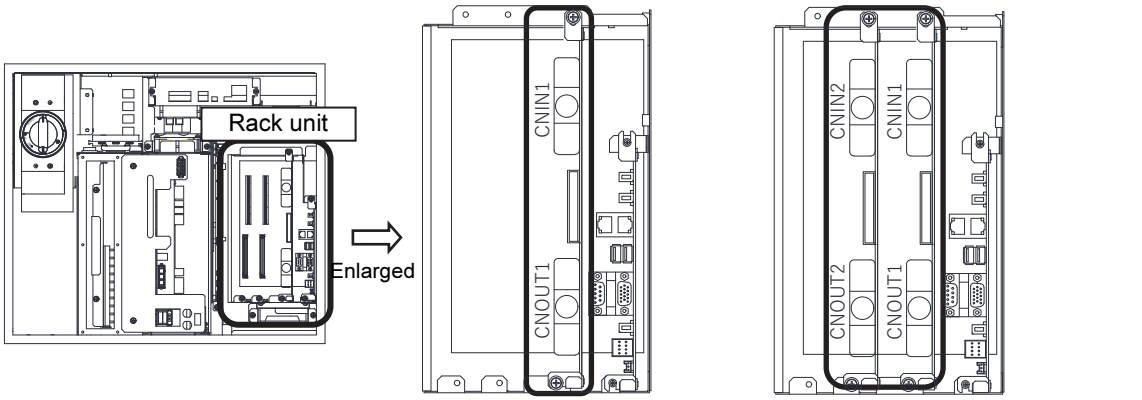
Table 3.5.2 I/O board

Condition	Number of signals	Output specification
I/O board	IN 32pts. / OUT 32pts. (IN64 pts. and OUT 64pts. at maximum)	Semiconductor output (NPN or PNP)

3.5.1.2 Installation position of the I/O Board

- If the robot system and I/O board are purchased at the same time, I/O board is pre-installed in the robot controller before shipment.
- If this board is purchased after purchasing the robot controller, please contact our service department for setting and installation work. Setting and installation work is available with additional charge.

Fig. 3.5.1. shows;
- Installation position of I/O board
- Terminal block position to be connected



I/O board is installed in rack unit.

FD20-OP125-A, -C (NPN 32 pts.)
FD20-OP151-A, -C (PNP 32 pts.)

FD20-OP125-B, -D (NPN 64 pts.)
FD20-OP151-B, -D (PNP 64 pts.)
In case of 64 pts specification, I/O board is added.

Fig. 3.5.1 Installation position of I/O board (showing FD20-OP125-A/B, FD20-OP151-A/B)

There is a clearance distance of about 70 mm from the I/O board connector to the door. When routing cables, make sure that the cables are not stressed.

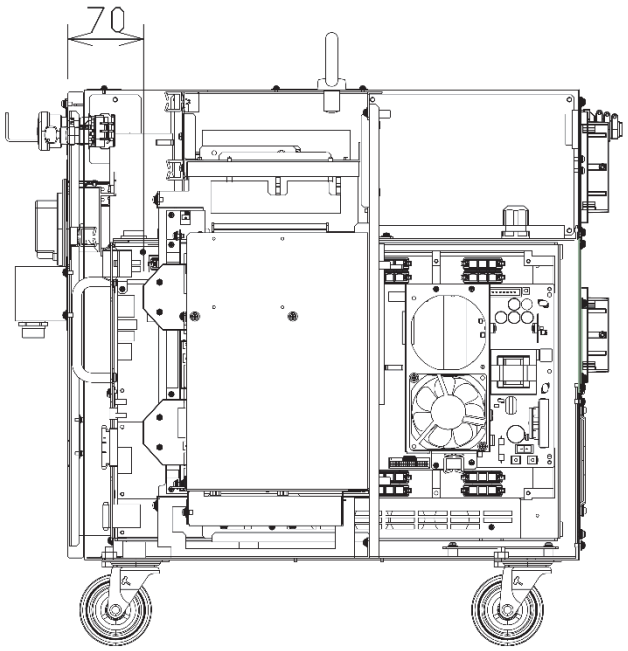


Fig. 3.5.2 Parts layout inside cabinet (right side)

INFO.

For details on the I/O board physical I/O signals, see below.
P. 3-30 “3.8.1 Common items”

CAUTION

After connecting the cables to the robot controller, close the panels completely. If the panels are not completely closed, dust or dirt will enter the robot controller, which may cause breakdown.

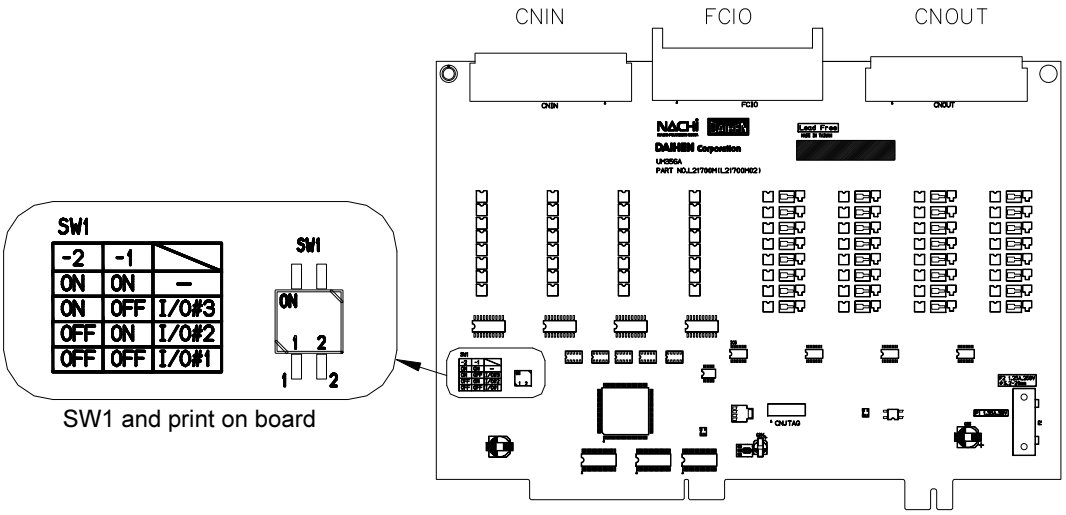
3.5.1.3 Dip switch setting of the I/O Board

If plural I/O boards are used, dip switch SW1 must be set adequately.
Before installing I/O board, please set SW1.
(If robot system and I/O board was purchased at the same time, this setting is unnecessary. Customer needs not have to do this work.)
Detail setting of dip switch SW1 is explained below table and figure
Dip switch SW1 is common for both FD20-OP125-A～D, FD20-OP151-A～D.

Table 3.5.3 Dip switch SW1 setting of I/O board

Location		Setting		Notes
Board name	No.	2	1	
I/O board	SW1	OFF	OFF	I/O board 1 (factory setting)
		OFF	ON	I/O board 2
		ON	OFF	Not used
		ON	ON	Not used

・FD20-OP125-A/B , FD20-OP151-A/B (Honta Tsushin connector specification)



・FD20-OP125-C/D , FD20-OP151-C/D (Phoenix contact connector specification)

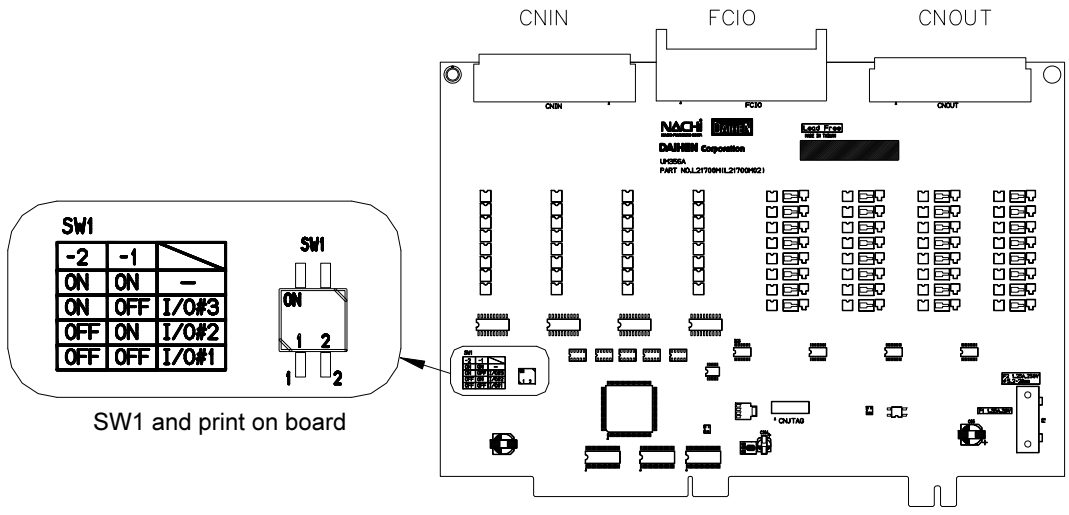


Fig. 3.5.3 Dip switch SW1 setting of I/O board

3.5.2 Mini I/O Option Installation

3.5.2.1 Overview of the Mini I/O Option

Mini I/O option is a configuration in which an unused I/O port of a safety sequence board is connected to a terminal block. One Mini I/O option can be installed in one robot controller
This section describes how to mount the Mini I/O option, and how to connect the I/O cable.
As for the electric specification, please refer to section 3.8.

Table 3.5.4 Mini I/O option

Number of signals	Output specification	Option parts No.
IN 14pts. / OUT 10pts.	PhotoMOS relay	FD20-OP150-A
IN 10 pts. / OUT 8 pts.	Relay Output	FD20-OP150-B

- If the robot system and Mini I/O option are purchased at the same time, they are pre-installed in the robot controller before shipment.
- If this board is purchased after purchasing the robot controller, please contact our service department for setting and installation work. Setting and installation work is available with additional charge.

3.5.2.2 Installation position of the Mini I/O option

The installation position of the I/O board and terminal connector are shown below.

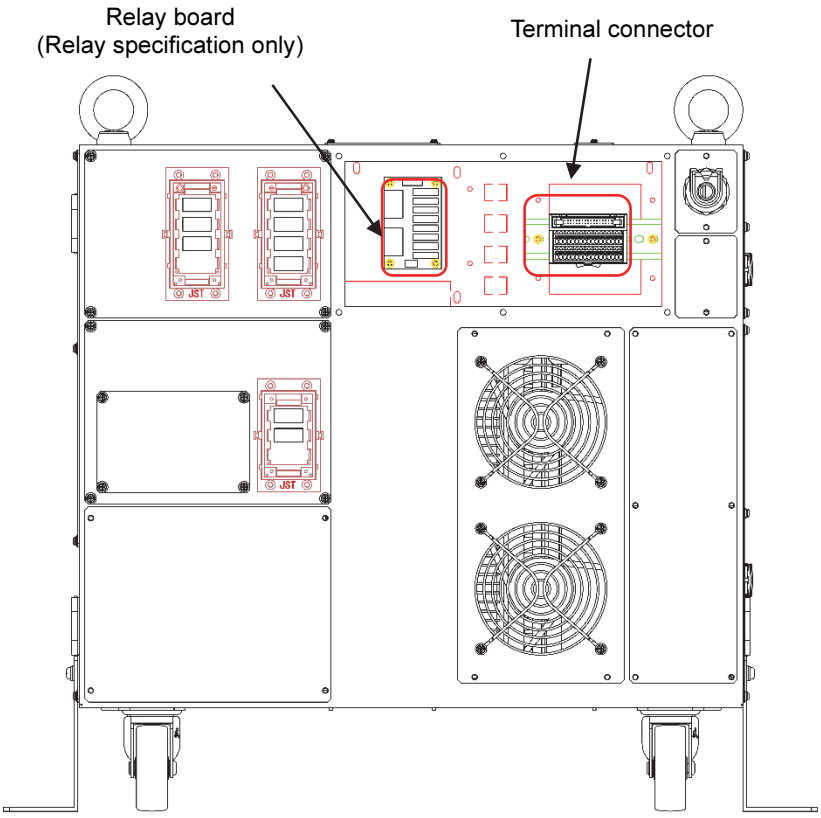


Fig. 3.5.4 Terminal connector and relay board positions

Wiring Method of the Physical I/O Signal Wires for Mini I/O Option

1 Turn off the primary power supply and circuit breaker on the controller.

2 Remove the cable inlet panel shown in Fig 3.5.5

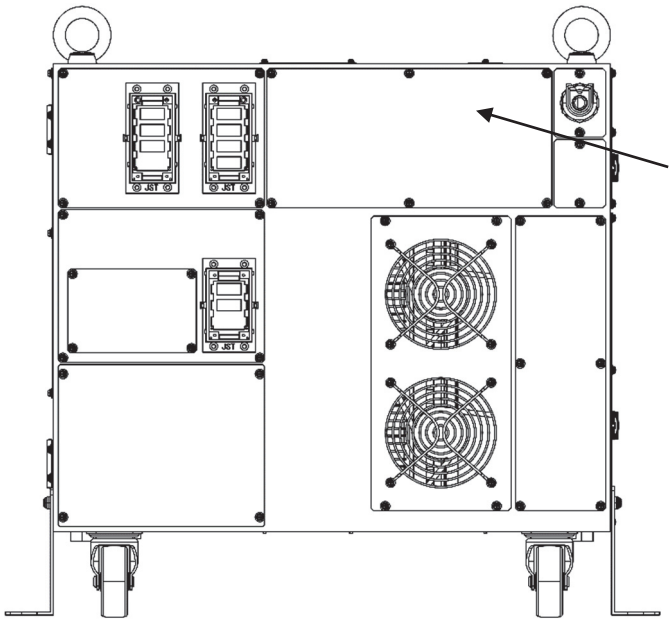
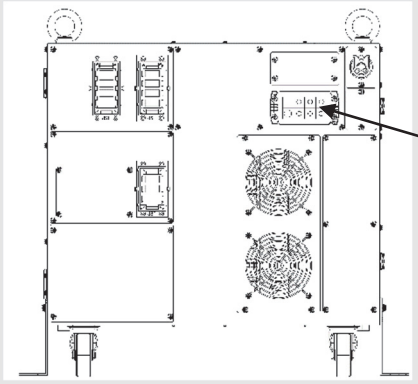


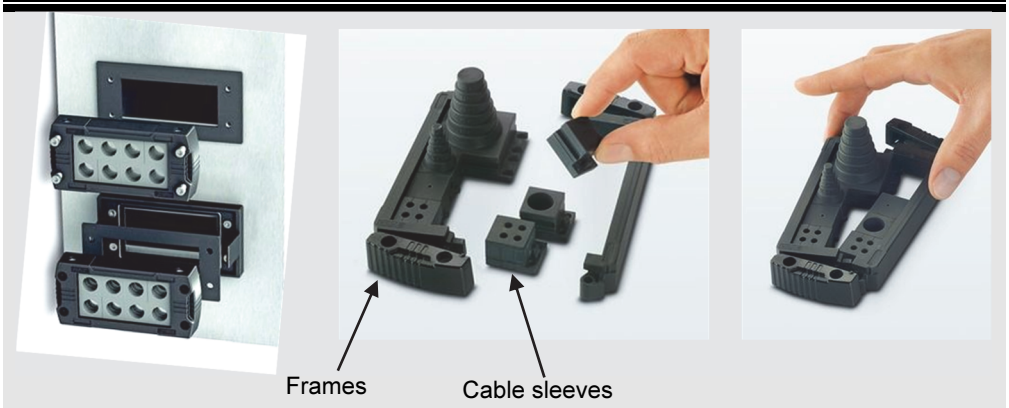
Fig. 3.5.5 Drawing in general I/O signal cables

3 Draw in the cable to the robot controller and fix it.



To fix cables, Cable entry system (FD20-OP193-*) is prepared as option.

※Cable entry system
It is possible to retract cables of various diameters without impairing the dust resistance by combining frames and various cable sleeves for cable entries.
As for the detail of applicable cable diameter, please refer to the standard specification “FD20 controller”, (SFDEN-026).
This system can be fixed utilizing the tap hole of a cable inlet.



4 Install the panel to the robot controller.

INFO.

For details on the relay board + I/O board physical I/O signals, see below.

P. 3-30 “3.8.1 Common items”
P. 3-43 “3.8.3 Signal specifications of Mini I/O option”
P. 4-65 “4.8 I/O area mapping function”

CAUTION

After connecting the cables to the robot controller, close the panels completely. If the panels are not completely closed, dust or dirt will enter the robot controller, which may cause breakdown.

3.6 Safety-related signal connections

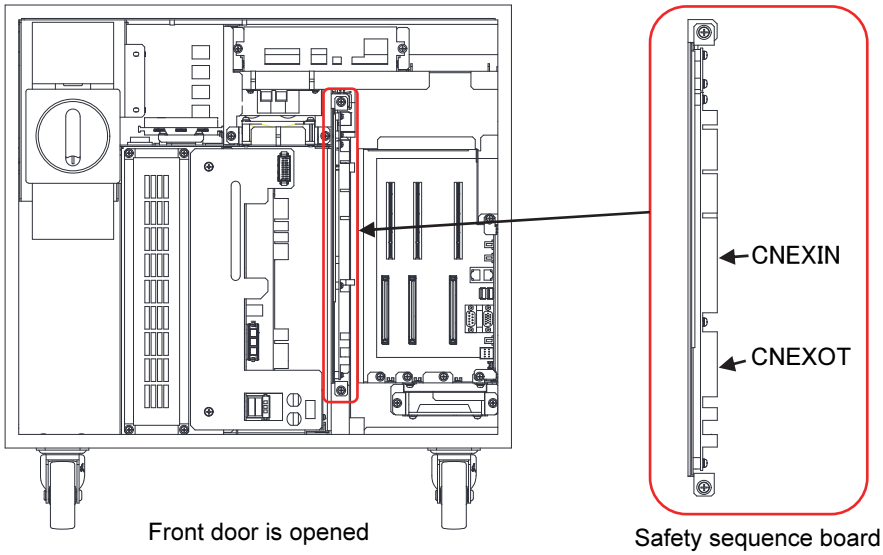
In this section, such safety-related signals as the emergency stop signal and safety plug signal will be connected. Be sure to connect these signals as a safety measure for operators who perform teaching work and as an emergency stop measure when a fault has occurred.
This controller comes with safety redundancy circuits as a standard feature. Connect a separate pair of signals each for the external emergency stop input, safety plug input and enable switch input. The controller will not work properly if any of the separate pairs of signal inputs are mismatched in the safety redundancy circuits.

CAUTION

A safety plug is required to perform the teaching work inside the safety fence.
If a safety plug is not going to be used, install a “switch that permits automatic start” outside the safety fence, ensure that it is constructed in such a way that it cannot easily be set to ON in case operators are working inside the safety fence, and connect its signal to the safety plug input.

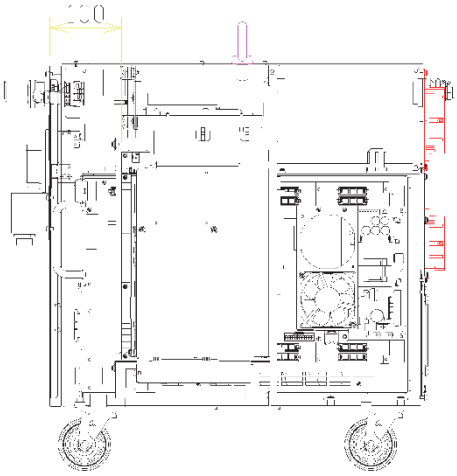
3.6.1 Safety sequence board

The terminals for the safety-related signals are on CNEXIN, CNEXOT on Safety sequence board. Position of this board is shown below.



Front door is opened

Safety sequence board enlarged figure



Parts layout inside cabinet (Right side)

There is a space distance of approximately 100 mm from the connector on the safety sequence board to the door. When routing cables to the safety sequence board, make sure that the cables are not stressed.

Fig. 3.6.1 Installation position of safety sequence board

3.6.2 Position of the terminal block

Fig. 3.6.2 shows the positions of terminal blocks CNEXIN and CNEXOT.

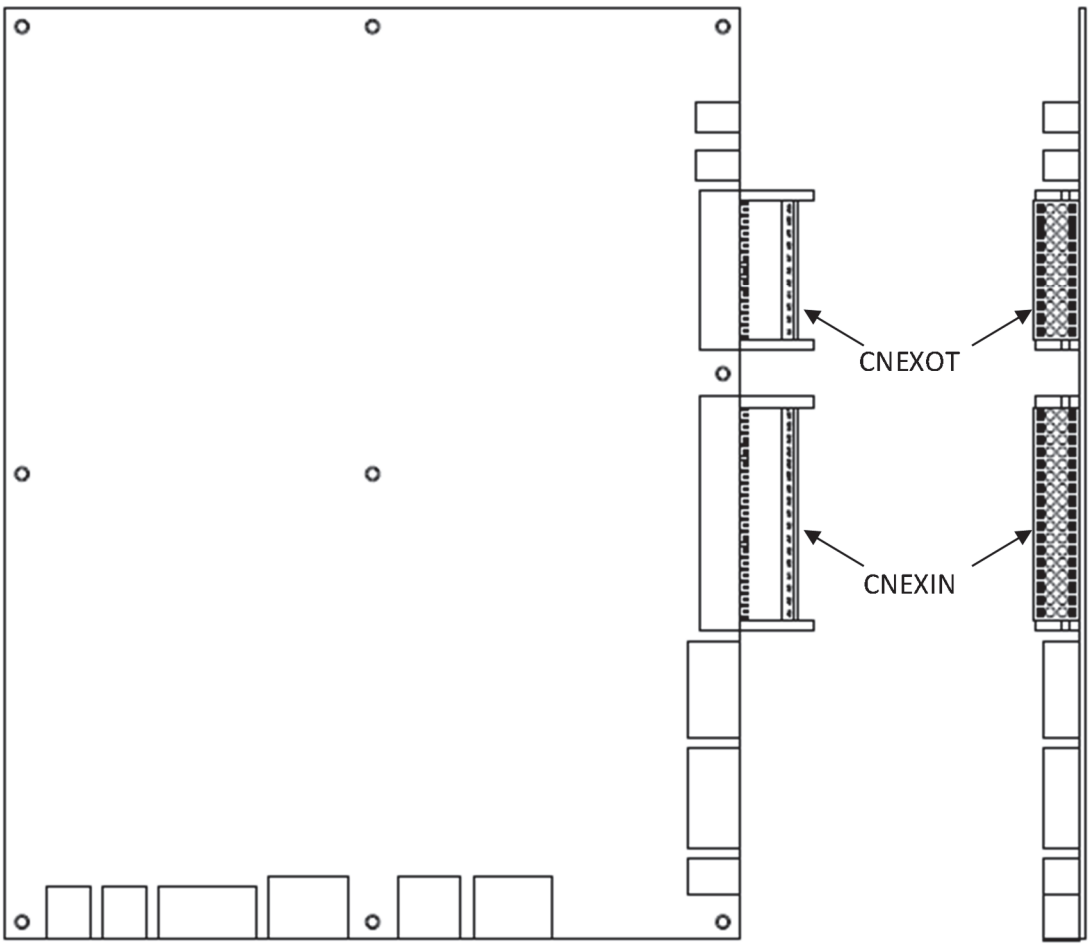
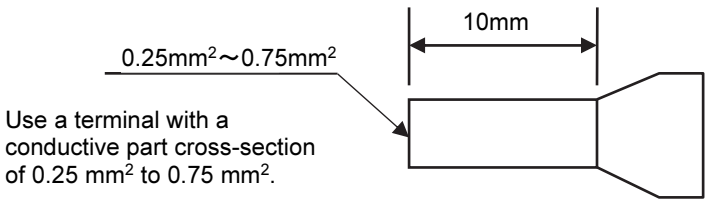
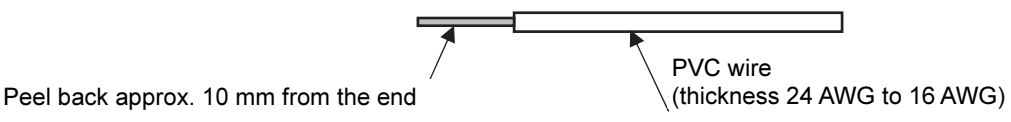


Fig. 3.6.2 CNEXIN, CNEXOT on safety sequence board

For the signal wire that will be connected to the terminal block, use a bar terminal (conductive part length of 10 mm, cross-section of 0.25 mm^2 to 0.75 mm^2) or a PVC wire (thickness 24 AWG to 16 AWG) with approximately 10 mm of the end peeled off.



<When connecting with a bar terminal>



<When connecting a PVC wire>

Fig. 3.6.3 Signal wires to connect to CNEXIN1 and CNEXOT

3.6.3 Pin layout of Terminal blocks

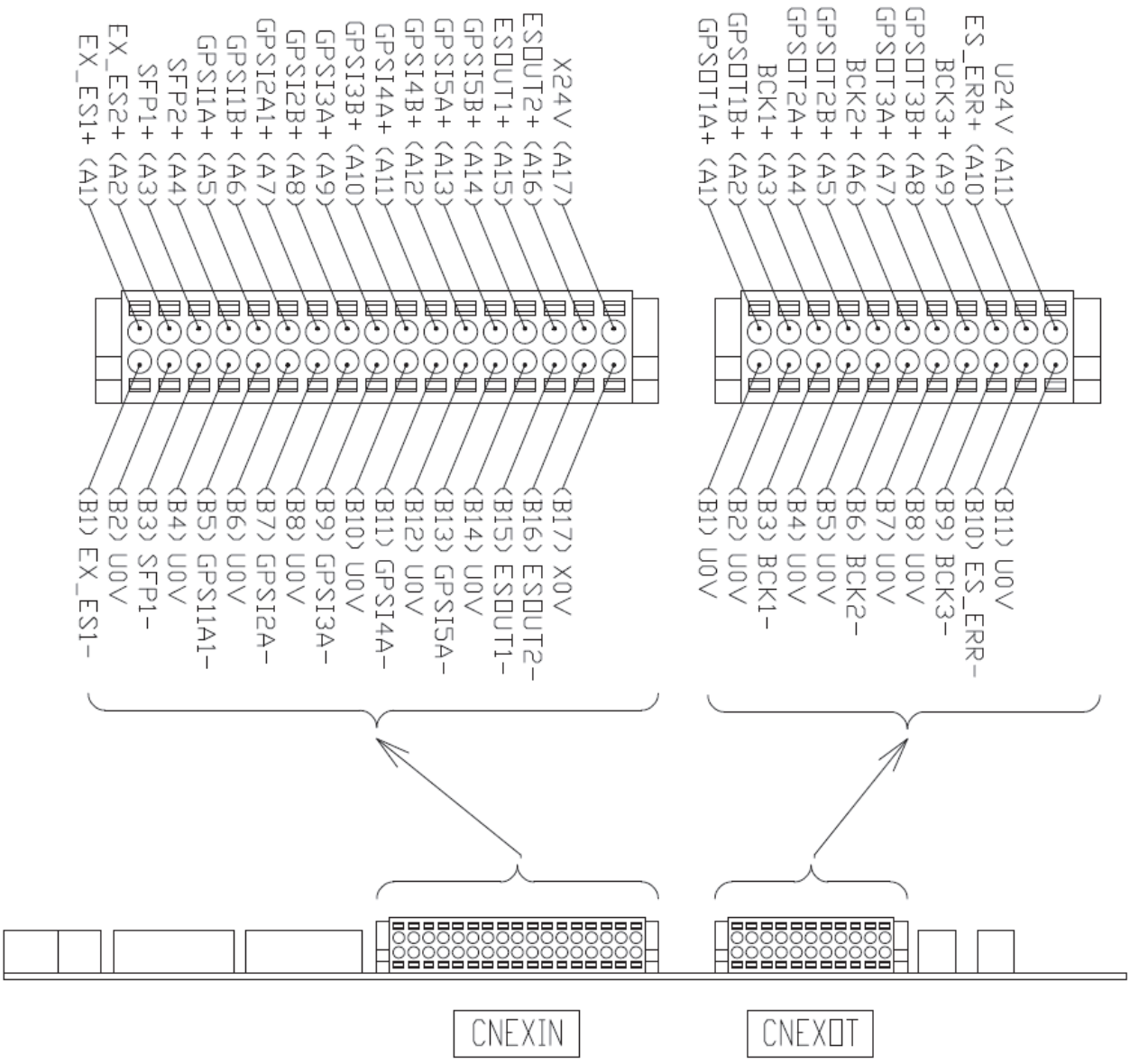


Fig. 3.6.4 Pin layout of CNEXIN and CNEXOT

In this controller, the “Motors ON external” signal is not included in the terminal block on the safety sequence board. So if you want to turn the Motors ON using the external PLC etc., it is necessary to assign a general input signal to the “Motors ON external” in advance. For “Motors ON external” signal, see “4.6.2 Standard input signals” also.

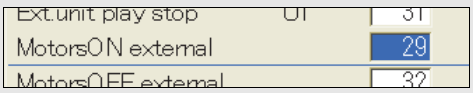


Table 3.6.1 Terminal block CNEXIN of Safety sequence board

Pin No.	Signal name	Function	Description
A1	EX_ES1	External emergency stop input 1+	This is an external emergency stop input terminal. When not using this terminal, connect jumper wires as shown below. Connect A2 and B2 Connect A1 and B1
B1		External emergency stop input 1-	
A2	EX_ES2	External emergency stop input 2+	
B2		External emergency stop input 2-	
A3	SFP1	Safety plug input 1+	This is a safety plug input terminal. Connect always. Refer to the section 3.6.6.2 on page 3-20
B3		Safety plug input 1-	
A4	SFP2	Safety plug input 2+	
B4		Safety plug input 2-	
A5	GPSI1A	General-purpose safety input 1A+	This is general-purpose safety input terminal 1.
B5		General-purpose safety input 1A-	
A6	CPSI1B	General-purpose safety input 1B+	
B6		General-purpose safety input 1B-	
A7	GPSI2A	General-purpose safety input 2A+	This is general-purpose safety input terminal 2.
B7		General-purpose safety input 2A-	
A8	CPSI2B	General-purpose safety input 2B+	
B8		General-purpose safety input 2B-	
A9	GPSI3A	General-purpose safety input 3A+	This is general-purpose safety input terminal 3.
B9		General-purpose safety input 3A-	
A10	CPSI3B	General-purpose safety input 3B+	
B10		General-purpose safety input 3B-	
A11	GPSI4A	General-purpose safety input 4A+	This is general-purpose safety input terminal 4.
B11		General-purpose safety input 4A-	
A12	CPSI4B	General-purpose safety input 4B+	
B12		General-purpose safety input 4B-	
A13	GPSI5A	General-purpose safety input 5A+	This is general-purpose safety input terminal 5.
B13		General-purpose safety input 5A-	
A14	CPSI5B	General-purpose safety input 5B+	
B14		General-purpose safety input 5B-	
A15	ESOUT1	Emergency stop output 1+ (dry contact)	Dry contact A output terminal to indicate the status of the emergency stop signal. When the Emergency stop button on the operation panel of the controller or the teach pendant is pressed, this signal turns OFF (the contact is open). This output signal has been designed dual. (The dry contact output has been provided in two individual systems.)
B15		Emergency stop output 1- (dry contact)	
A16	ESOUT2	Emergency stop output 2+ (dry contact)	
B16		Emergency stop output 2- (dry contact)	
A17	X24V	External power DC24V input	By supplying external power (DC24V) between the X24V and X0V terminals, the emergency stop circuit can be operated even if the robot controller power is cut, and ESOUT1 and ESOUT2 can be turned ON/OFF by the status of the emergency stop button. Switching between internal power use (factory setting) and external power supply use is done using a J1 jumper pin. For details on J1 settings, see Fig. 3.6.5 and Fig. 3.6.6.
B17	X0V	Ground	

CAUTION

When using an external emergency stop button, safety plug or general-purpose safety input, always double-up on connection points.
(E.g.: When an external emergency stop button is used: Pin A1-B1 and Pin A2-B2)

Table 3.6.2 Terminal block CNEXOT of Safety sequence board

Pin No.	Signal name	Function	Description
A1	GPSOT1A	General-purpose safety output 1A+	This is general-purpose safety output terminal 1. The - side is internally connected to U0V.
B1		General-purpose safety output 1A-	
A2	GPSOT1B	General-purpose safety output 1B+	
B2		General-purpose safety output 1B-	
A3	BCK1	Backcheck 1+	This is the backcheck terminal of general-purpose safety output 1.
B3		Backcheck 1-	
A4	GPSOT2A	General-purpose safety output 2A+	This is general-purpose safety output terminal 2. The - side is internally connected to U0V.
B4		General-purpose safety output 2A-	
A5	GPSOT2B	General-purpose safety output 2B+	
B5		General-purpose safety output 2B-	
A6	BCK2	Backcheck 2+	This is the backcheck terminal of general-purpose safety output 2.
B6		Backcheck 2-	
A7	GPSOT3A	General-purpose safety output 3A+	This is general-purpose safety output terminal 3. The - side is internally connected to U0V.
B7		General-purpose safety output 3A-	
A8	GPSOT3B	General-purpose safety output 3B+	
B8		General-purpose safety output 3B-	
A9	BCK3	Backcheck 3+	This is the backcheck terminal of general-purpose safety output 3.
B9		Backcheck 3-	
A10	ES_ERR	CPU error +	Dry contact A output terminal to indicate the status of CPU.
B10		CPU error -	
A11	U24V	Power 24 V	
B11	U0V	GND	

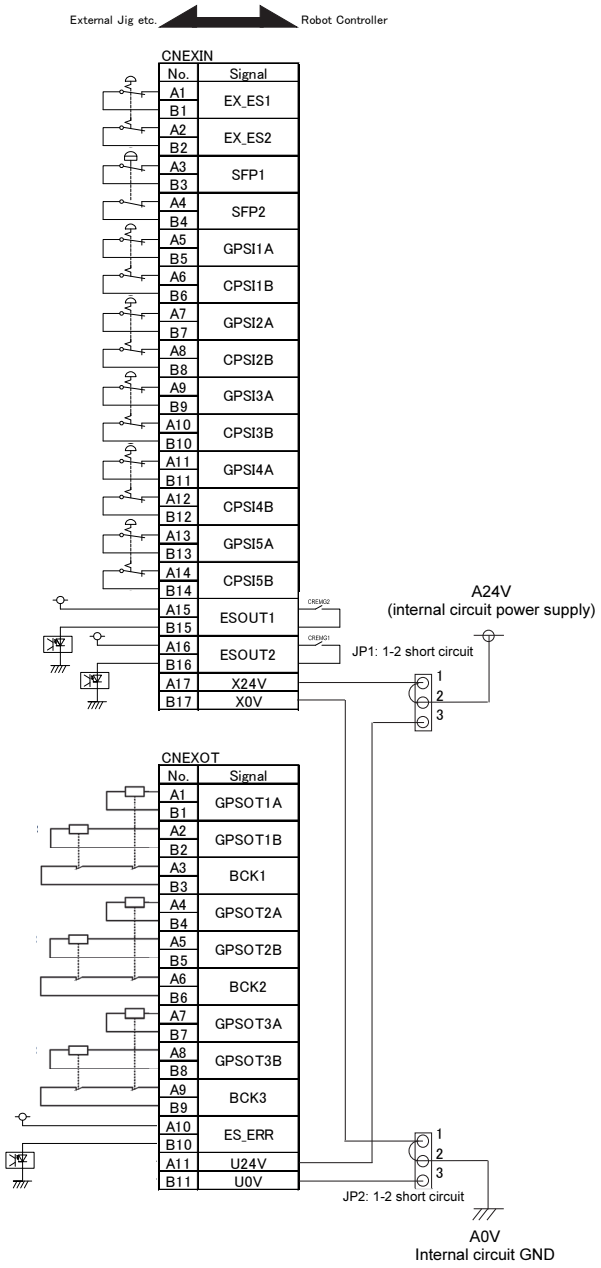


Fig. 3.6.5 Connection example of CNEXIN, CNEXOT (DC24V external power)

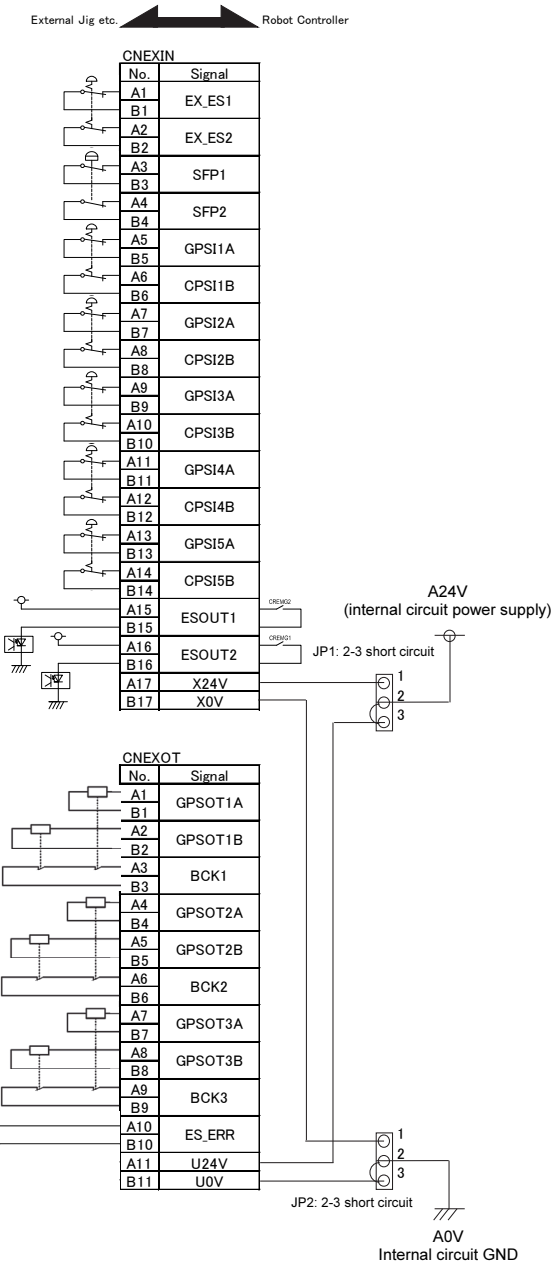


Fig. 3.6.6 Connection example of CNEXIN, CNEXOT (DC24V internal power)

CAUTION

Do not use the U24V, U0V terminal outside the robot controller since this is for the internal use only.

3.6.4 Electrical specification of input terminal block

Table 3.6.3 shows the power specifications for 1 input signal point.

Table 3.6.3 Electrical specifications of input terminal block

Items	Specifications
Input impedance	Approx. 4.3 kΩ
Input voltage	DC+24V ±10%
Input current	5 mA (typ.)

Table 3.6.4, Fig. 3.6.7 and Fig. 3.6.8 show the input load (customer prepared) specifications.

Table 3.6.4 Specifications of the load for input circuit (customer preparation required)

Input load (Customer prepared)	Specifications	Remarks
Relay contact	Minimum applicable load should be DC24V, 3 mA	The input signals needs to be closed for 150 ms or longer.
Open collector device	Leakage current should be 1 uA or less.	

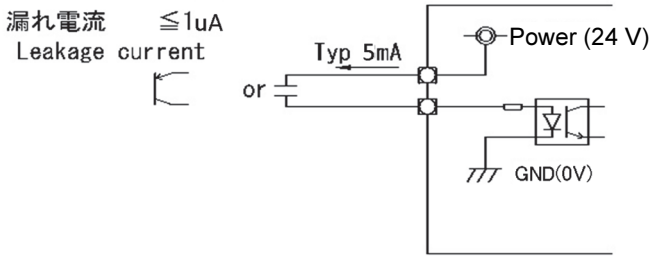


Fig. 3.6.7 Connection specifications of EX_ES1, SFP1, GPSI*A

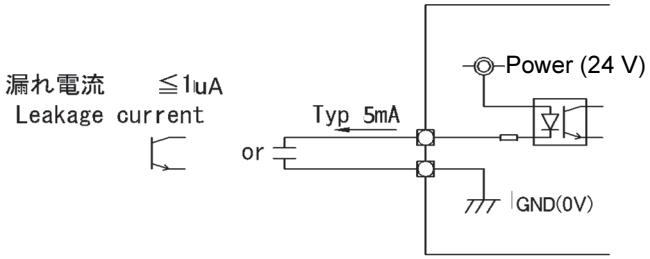


Fig. 3.6.8 Connection specifications of EX_ES2, SFP2, GPSI*B

3.6.5 Electrical specifications of output terminal block

3.6.5.1 Electrical specifications of emergency stop output (ESOUT1, ESOUT2)

Table 3.6.5 shows the power specifications for 1 emergency stop output signal point.
Prepare the output load that conforms to these specifications.

Table 3.6.5 Electrical specifications of emergency stop output terminal block

Items	Specifications
Output method	Relay contact
Rated voltage	AC 100 V or DC 30 V
Rated current	3A
Minimum applicable load	DC1V 1 mA
Electrical expected life	More than 50,000 times (5 A, AC100V, 5 A, DC30V, resistive load, at 6 times/min.)

CAUTION

1 Be absolutely sure to use a surge killer for the load.
2 Since the value of minimum applicable load depends on the switching frequency, environment conditions, and expected reliable level, be sure to check with the actual load condition before operation.
3 Electrical expected value is a reference value in case of using under the conditions described in parentheses. The value depends on the environmental conditions.

3.6.5.2 Electrical specifications of general-purpose safety output (GPSOT**)

Table 3.6.5 shows the power specifications for 1 general-purpose safety output signal point.
Prepare the output load that conforms to these specifications.
For the use method of the general-purpose safety output, refer to the instruction manual “FD18 controller Robot Monitoring Unit RMU40-20”.

Table 3.6.6 Electrical specifications of general-purpose safety output terminal block

Items	Specifications
Output method	Semiconductor output
Output voltage	24V(typ)
Rated current	1.3A
Leak current	5uA(max)

3.6.6 Connection procedures on input terminal block

For details on connections for each input terminal, see sections 3.6.6.1 to 3.6.6.4.

3.6.6.1 External emergency stop input (CNEXIN: A1-B1, A2-B2)

As soon as the external emergency stop input signal becomes open under any circumstances whatsoever, the brake is quickly applied to the robot, and the motor power (servo power) is cut off by the hardware circuits.
Input the emergency stop command from the emergency stop button or host controller. The separate pairs of signal inputs must perform the same operations. Connect single normally closed contact between terminals 1 and 2 and another one between terminals 3 and 4. Connect single normally closed contact between terminals A1 and B1 and another one between terminals A2 and B2. Bear in mind that the connections given in Fig. 3.6.10 is not permitted.

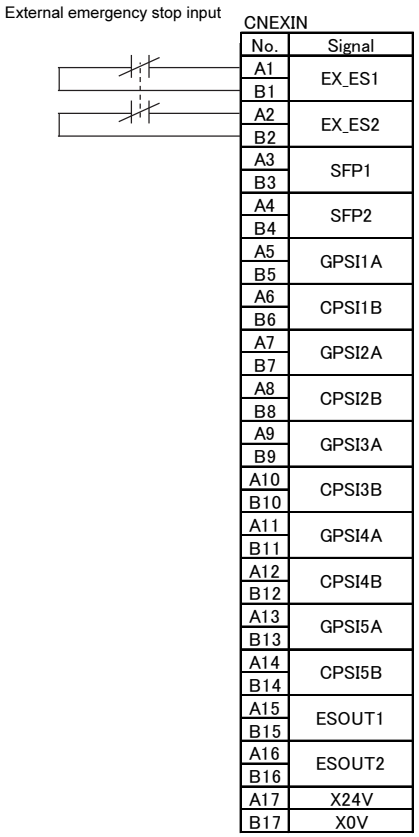


Fig. 3.6.9 Connection diagram of external emergency stop input

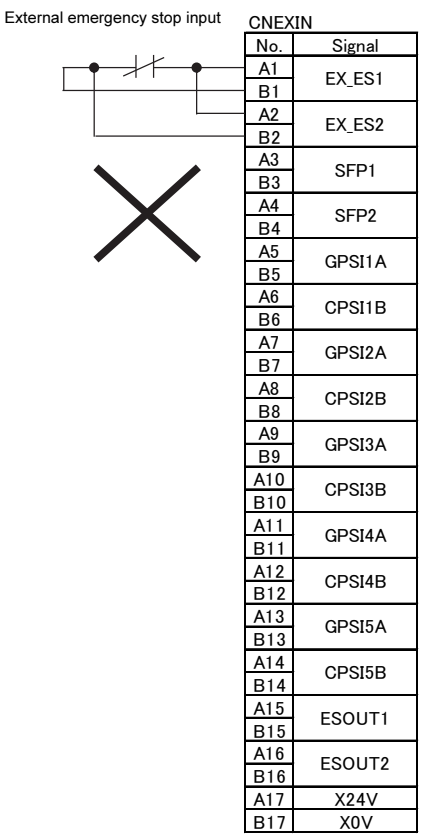


Fig. 3.6.10 Not permitted connection diagram of external emergency stop input

3.6.6.2 Safety plug input (CNEXIN : A3-B3, A4-B4)

The guard fence must have a door for allowing the operators to move in and out. Provide a safety plug to ensure that the robot will be stopped automatically when the door is opened to ensure that operators will not enter inside the guard fence without due reason while the robot is operating, and connect the signals of the plug to the safety plug input on the robot controller. The separate pairs of signal inputs must perform the same operations.
Bear in mind that the connections given in Fig. 3.6.13 is not permitted.

If the safety plug input signal is left open during auto operation, the brake is quickly applied to the robot as for emergency stop, and the motor power (servo power) is cut off by the hardware circuits. In this case, by switching to teach mode, operation preparation (servo power) can be supplied once again in safety plug input signal open status. However, the operation speed is limited to low speed (speed of 250mm/sec or below at tool end).

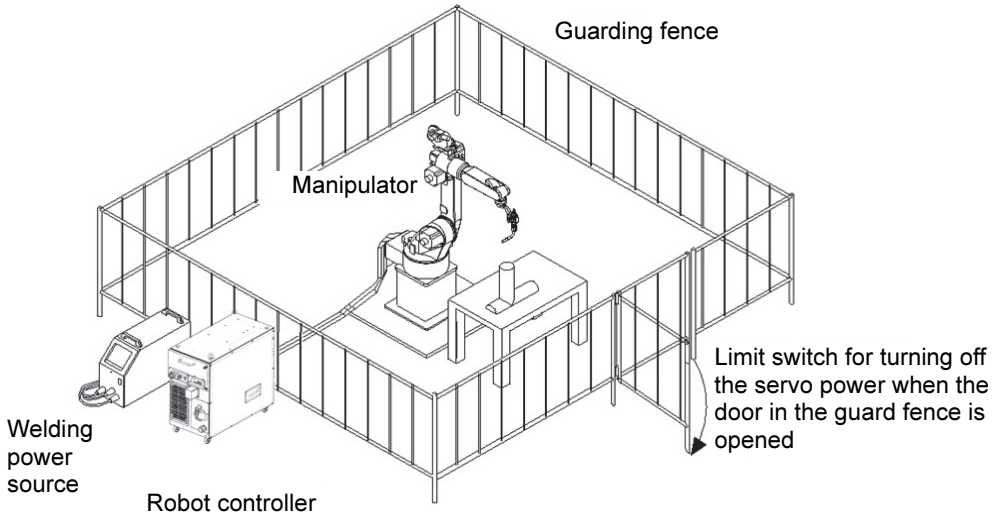


Fig. 3.6.11 Safety plug installed on Guard fence door

CAUTION

In playback mode, the servo power cannot be switched ON unless the safety plug input is ON. Always connect the safety plug.

[Condition of the safety plug input signals that is required for turning ON the motors power]

TEACH mode: When both in opened and closed, motor ON is available.
(The speed is limited to 250 mm/s.)
(If the opened/closed status changes, the motors are turned OFF for the present.)

PLAYBACK mode: Available only in closed state.
(The limit of 250 mm/s is not applied.)

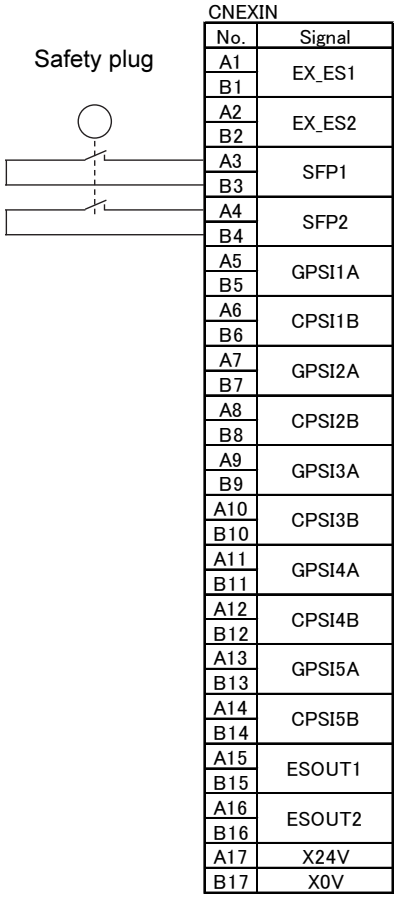


Fig. 3.6.12 Connection diagram of safety plug input

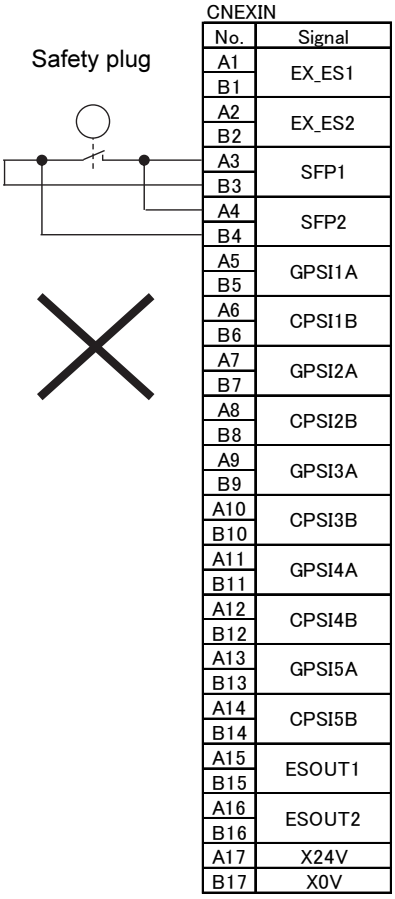


Fig. 3.6.13 Not permitted connection diagram of safety plug input

3.6.6.3 General purpose safety inputs (CNEXIN : A5-B5, A6-B6, A7-B7, A8-B8, A9-B9, A10-B10 A11-B11, A12-B12, A13-B13, A14-B14)

If the general-purpose safety input is used, as soon as the general-purpose safety input becomes open, the brake is quickly applied to the robot and it stops. The motor power (servo power) is cut off in a case other than a protective stop. (In the case of a protective stop, it is not cut off.) Two independent input signals are required to do the same operation. Connect single normally closed contact between terminals as shown in Fig. 3.6.14. Bear in mind that the connections given in Fig. 3.6.15 is not permitted.
For the use method of the general-purpose safety input, refer to the instruction manual of “FD18 controller Robot Monitoring Unit RMU40-20”.

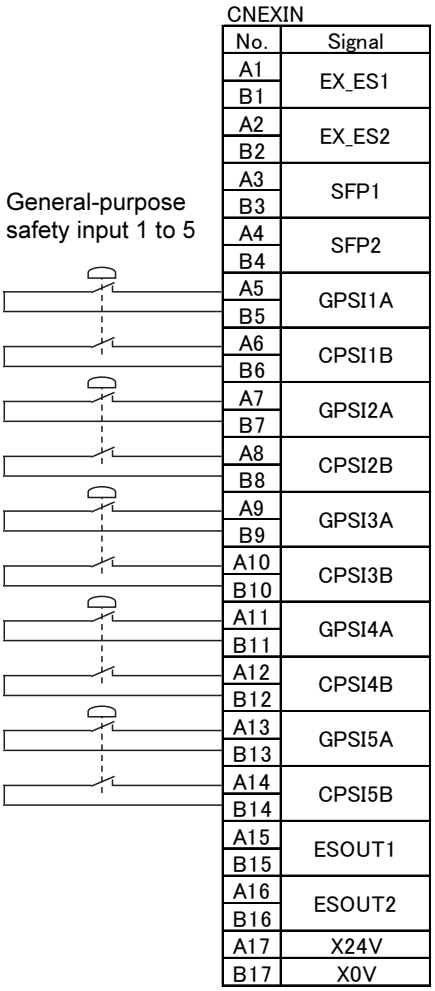


Fig. 3.6.14 Connection diagram of general-purpose safety inputs

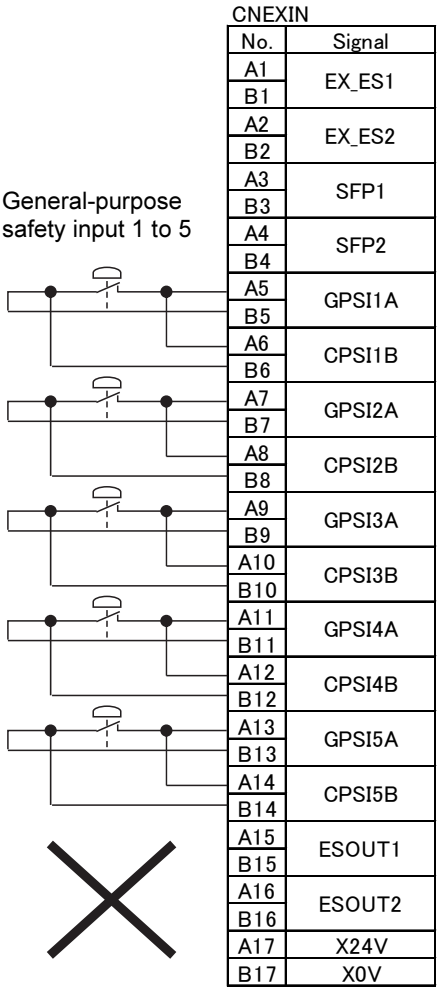


Fig. 3.6.15 Not permitted connection diagram of the general-purpose safety inputs

3.6.6.4 Connections when the robot controller is in stand-alone

When the robot controller is not going to be connected to an external device but used in stand-alone, perform the connections shown below. The external emergency stop is shorted, but connect the safety plug for detecting that the door of the guard fence has been opened to the safety plug inputs. If an input is assigned, short-circuit the general-purpose safety input.

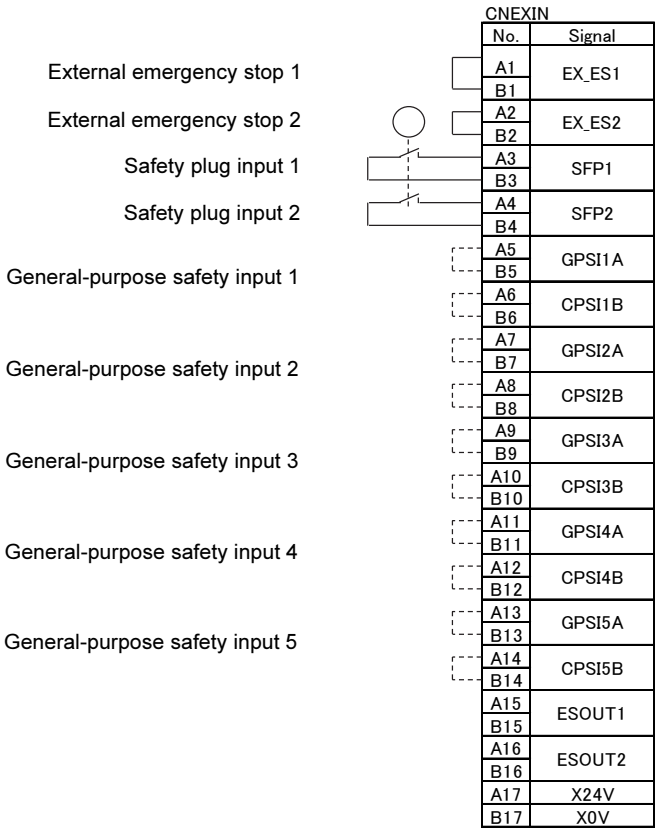


Fig. 3.6.16 Diagram of connections when the robot controller is to be used in stand-alone

3.6.7 Emergency stop output connection (CNEXIN : 1-2, 3-4)

Internal electrical circuit of Emergency stop output is shown in Fig. 3.6.17.

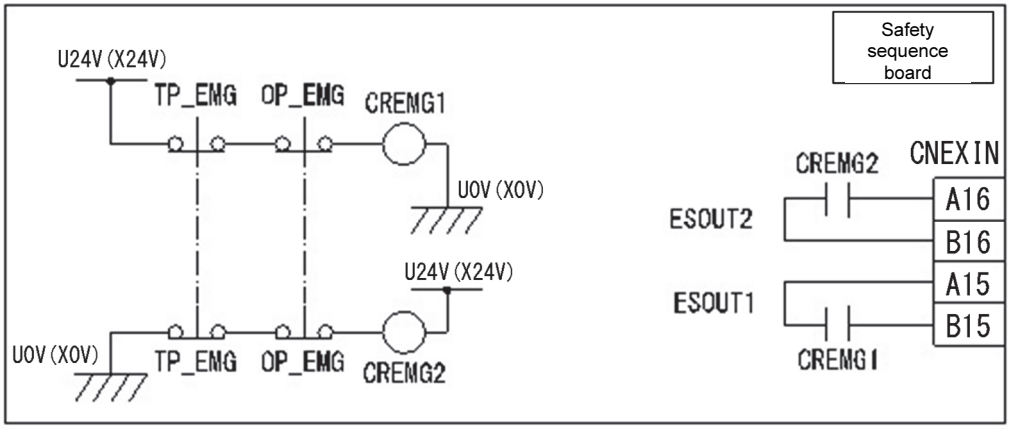


Fig. 3.6.17 Internal electrical circuit of Emergency stop output

The emergency stop output circuit uses internal power supply of the controller, and when the power supply of the controller becomes OFF, the emergency stop button output signal becomes OFF too.
In the case to use the emergency stop output even when the controller is OFF, supply external power from CNEXIN, and change the setting of the above jumper (J1)

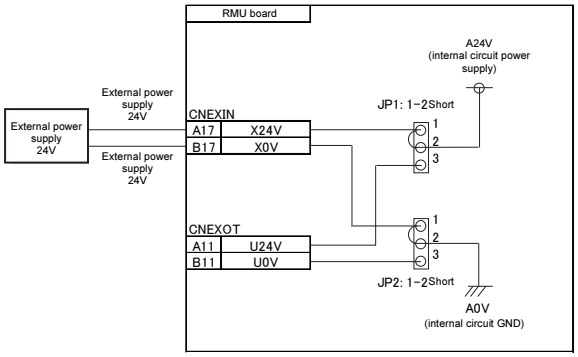


Fig. 3.6.18 In case that emergency stop circuit is used by external DC24V

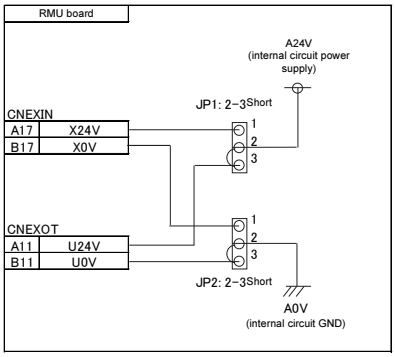


Fig. 3.6.19 In case that emergency stop circuit is used by internal DC24V (factory setting)

3.7 Primary power supply connection

3.7.1 Prior to Primary power supply connections

1. Electric shock may cause serious injury or death.
   Wiring work should be done after turning off the primary power supply and circuit breaker on the controller.
2. Check that the voltage of the primary power supply matches with the voltage specification of the robot controller. The voltage of the robot controller is indicated near the circuit breaker.
3. In case that the rated voltage other than AC200V/220V±10% 3ϕ 50/60Hz Type D grounding is specified at time of order, the proper transformer is pre-installed to the robot controller before shipment. If the robot controller is used at the different voltage from the one at time of order after the delivery, reconfigure the setting of the transformer. For details of transformer refer to the instruction manual “CONTROLLER MAINTENANCE”.

For the specifications of robot system, please refer to the respective “Standard specification“ or instruction manual “MANIPULATOR”.

1. When multiple manipulators or external axes are combined, a power capacity equivalent to the total power of all the machines is required.
2. When using a transformer, calculate the power capacity of the entire system.

3.7.2 Primary power supply connections

1 Turn off the primary power supply and circuit breaker on the controller.

2 Remove the breaker panel at the breaker part.
Connect the primary cable to the circuit breaker on the robot controller through the cable bushing accessory. Use the following cable for the primary power supply cable.
The cable clamps are included only on the rear panel, so if power is input from the left side, replace the cable clamps with those on the rear panel.

Table 3.7.1 Cable specifications of primary power

Manipulator used in combination	Cross-section of power cable	Crimp-style terminal of no-fuse circuit breaker	Cross-section of grounding cable	Crimp-style terminal of grounding cable
SRA, MC, etc.	3.5 mm^2 or more	Japan, China, Europe M5 round crimp-style terminal (Example; 3.5 - 5) North America (Transformer spec.) M8 round crimp-style terminal (Example; 3.5 - 8)	5.5 mm^2 or more	M5 round crimp-style terminal (Example; 5.5 - 5)

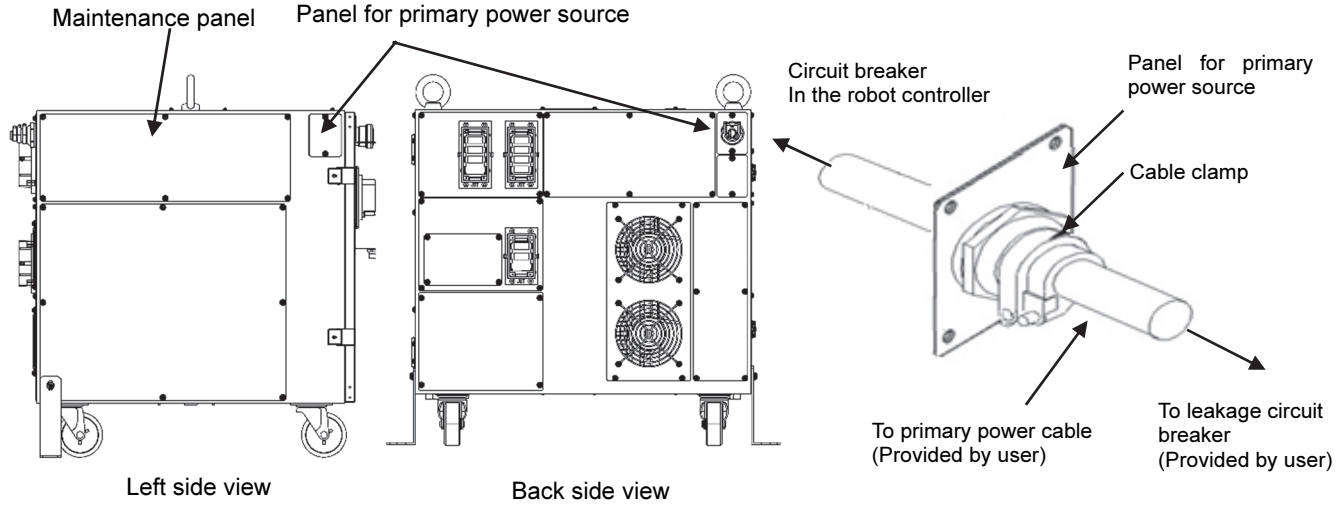


Fig. 3.7.1 Primary power supply cable

3 Remove the terminal cover of circuit braker.

4 As shown in Fig. 3.7.2, connect the primary power cable to the primary side of the breaker, and the ground wire to the ground terminal (PE).
If power cable comes from the back of controller, remove the maintenance panel of left side for safety work.

5 Attach the breaker panel to the robot controller.

CAUTION

Always attach the primary power cable with a cable clamp, and pull it through to the robot controller. If a cable clamp is not installed, water or dust may get inside the robot controller, which may cause a failure.

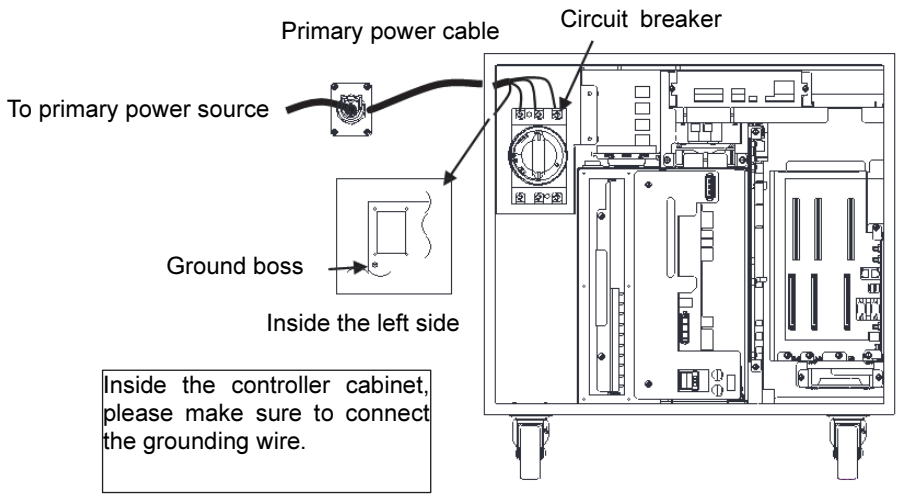


Fig. 3.7.2 Connection of the primary cable

6 Between the circuit breakers on the robot controller and power supply source, install a Wiring circuit breaker or Leakage circuit breaker.

Table 3.7.2 Braker specification for each manipulator

Manipulator used in combination	Braker specification
SRA, MC, etc.	Japan：40A China：30A Europe：30A North America：15A

CAUTION

1. An inverter circuit for controlling the AC servo motor is used in this robot controller. In order to prevent the leakage circuit breaker from being tripped in error by the high-frequency leakage current generated from the inverter circuit, the leakage circuit breaker must be designated for inverter use when one is to be used.
2. When installing the leakage circuit breaker, use one with a medium current sensitivity(100 mA or more).
3. Value in the table is typical value. Please refer to the delivery specification sheet at the same time.
4. The values in the table indicate the current values for one robot controller. When multiple controllers are connected to the same beaker, prepare a breaker with a capacity of the sum of the corresponding values in the table.
5. The Model with a built-in transformer must be connected to one of the following grounding system power supplies.
   ・TN grounding system (power supply side earth (N) and controller side earth (PE) are common grounding)
   ・TT grounding system (power supply side earth (N) and controller side earth (PE) are separate grounding)

IMPORTANT

When multiple manipulators or external axes are combined, the breaker capacity that you should prepare is different.

7 When connecting welding power supply, also install a wiring circuit breaker (3-phase, AC200V) that is compatible with the used primary welding electric current or a leakage breaker.

For details on the breakers suitable for welders, see the instruction manual for each welder.

In order to minimize the effect of noise due to current leakage, supply the primary power of the robot controller and primary power of the welding power supply from separate power supplies. In addition, connect the grounding terminals on the robot controller and welding power supply separately and isolate the connections from each other.

To ensure safety, ground the equipment without fail.

3.7.3 Grounding

For handling or spot welding specifications (including large-sized manipulator)

When using the robot in Japan, comply with relevant laws and regulations and perform type D grounding to ensure safety. (The customer is responsible for providing the grounding.)

- Ensure that the robot controller power cable is larger than 3.5 mm^2, and ground cable is larger than 5.5 mm^2. Also, connect an independent ground cable. The ground terminal for the robot controller is on the upper part of the breaker.

- When adding an external axis, pull out the ground wire from the metal case of the motor to be installed, and ground the external axis motor independently. A ground cable of 3.5 mm^2 or higher is recommended.

- For details on grounding the welding power supply, see the instruction manual for each welder.

- For each ground cable, use as short a cable as possible.

- Set the ground resistance to less than 100 ohms.

- When grounding the robot controller, never share the grounding wires or grounding rods with other power supplies or motor power.

- When using metal pipes, ducts or distributing frames to install grounding cables, ground the metal pipes, etc. in compliance with the technical standards governing electrical apparatus.

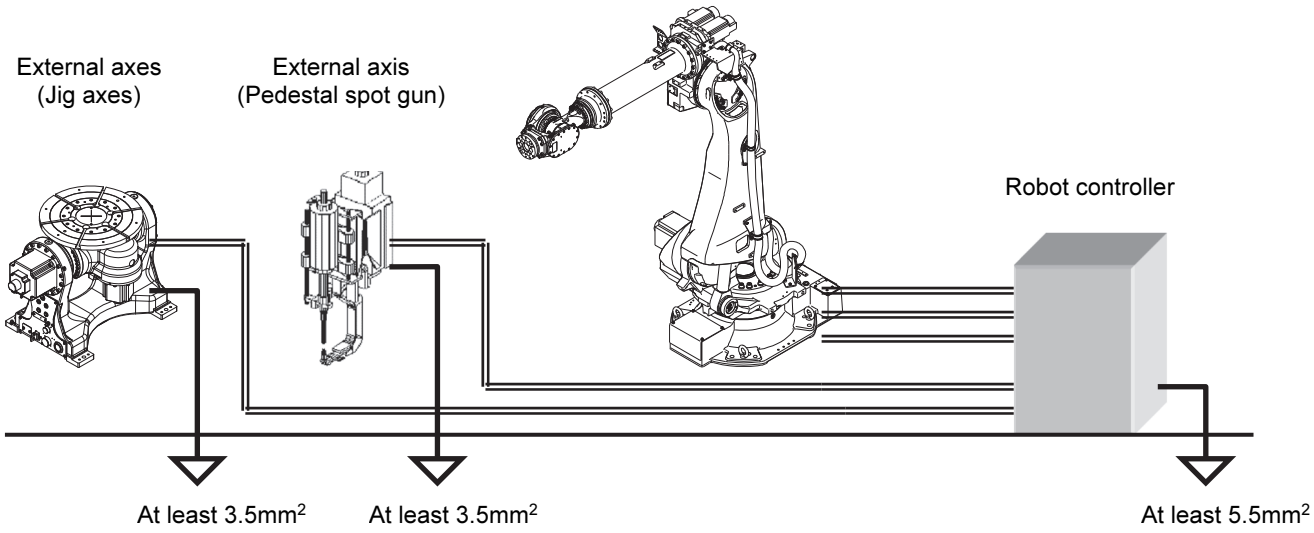


Fig. 3.7.3 Grounding

3.8 Signal specifications of Optional Physical I/O board

This section explains the physical I/O signal specifications for I/O board. Refer to Table 3.8.1, and refer to the correct explanation for your board.

Table 3.8.1 Reference Explanations for Each Board

Board name	Reference	
	Common items	Individual
I/O board	p3-30 Section 3.8.1	p3-31 Section 3.8.2
Mini I/O option		p3-43 Section 3.8.3

3.8.1 Common items

3.8.1.1 DC24V supplying procedure

The capacity for the DC24V that can be supplied by the internal DC24V is 0.8A.
If the input/output current for the used external device exceeds this value, you need to prepare an external DC24V power supply.
In case of supplying the internal DC24V to the external device, the Relay Board cannot be combined due to the capacity limitation of the internal DC24V.

3.8.1.2 Electrical specifications of physical input

Table 3.8.2 shows the power specifications for 1 input signal point. This is the same for all boards.

Table 3.8.2 Electrical specifications of physical input

Items	Specifications
Input impedance	Approx. 2.4 kΩ
Input voltage	DC+24 V ±10 %
Input current	10 mA (typ.)

Table 3.8.3 and Fig. 3.8.1 show the input load (customer prepared) specifications.

Table 3.8.3 Specifications of the load for input circuit (prepared by customer)

Input load (Customer prepared)	Specifications	Remarks
In case of Relay contact	Minimum applicable load should be DC24V, 5 mA	The input signals needs to be closed for 150ms or longer.
In case of Open collector device	Leakage current should be 1 mA or less.	

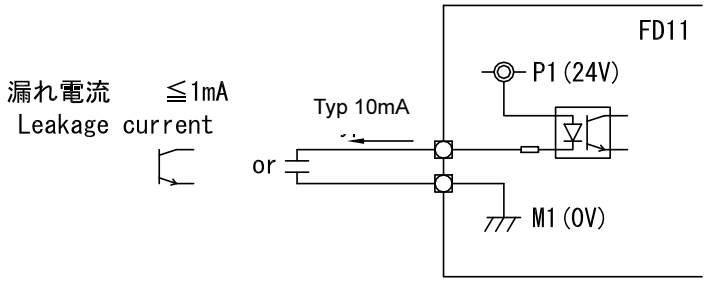


Fig. 3.8.1 Specifications of the load for input circuit (prepared by customer)

3.8.1.3 Electrical specifications of physical output

Table below shows the electrical specifications for one output signal point for each board.
Prepare the output load that conforms to the used physical output signal.

Electrical specifications of physical output (I/O board, Mini I/O option)

Table 3.8.4 Electrical specifications of physical output (I/O board, Mini I/O)

Items	Specifications
Rated voltage	DC+24 V ±3 V
Permitted load current (maximum)	0.2 A

CAUTION

- Be absolutely sure to use a surge killer for the load.
- Do not use power with the wrong polarity.

3.8.2 I/O signal specifications of I/O board

Refer to the sections shown in Table 3.8.5 according to the DC24V supply method.
For details of the initial settings of signal allocations, refer to “4.6.2 Basic input signals” and “4.6.3 Basic output signals”.

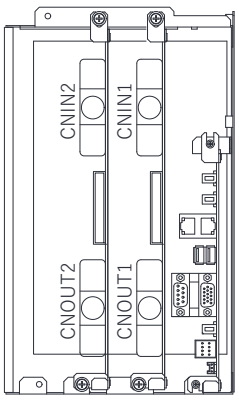
Table 3.8.5 External DC24V Power Supply

Parts No.	IO type	Connector No.	Connector Manufacturer	Referring to	
				I/O signal specification	Connection procedure
FD20-OP125-A/B FD20-OP151-A/B	Input	CNIN1, 2	Honta Tsushin	p 3-34 Table 3.8.6	p 3-38 Section 3.8.2.3
	Output	CNOUT1,2	Honta Tsushin	p 3-35 Table 3.8.7	
FD20-OP125-C/D FD20-OP151-C/D	Input	CNIN1,2,3,4	Phoenix contact	p 3-36 Table 3.8.8	p 3-38 Section 3.8.2.3
	Output	CNOUT1,2,3,4	Phoenix contact	p 3-37 Table 3.8.9	

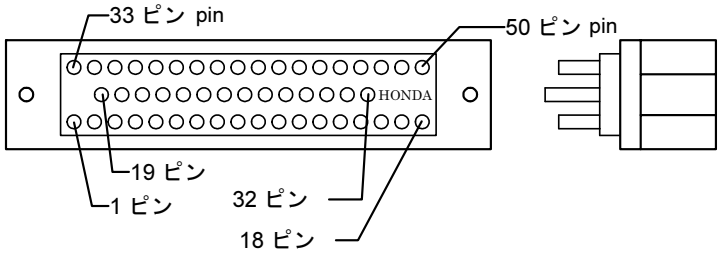
3.8.2.1 Input signal connector CNIN1,2 and output signal connector CNOUT1,2 of I/O board

I/O board has connector for general-purpose input signals (CNIN1, 2) and general-purpose output signals (CNOUT1, 2). It is possible to use by assigning signals of 32 points to general-purpose input signals and 32 points to general-purpose output signals respectively.
Up to 2 I/O boards can be mounted as option, that is 64 inputs and 64 outputs at maximum.

Pin arrangement of connector CNIN and CNOUT

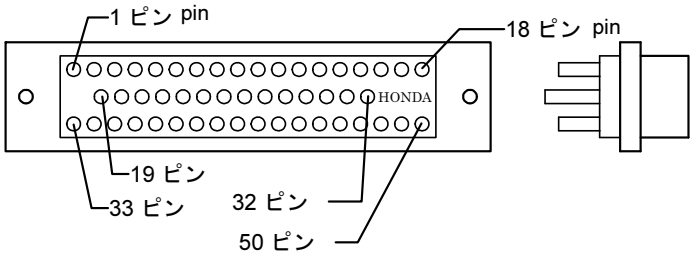


CNIN pin arrangement is the view from the soldering side.
Connecter type : MR-50LM (soldering type male connector : Honta Tsushin)



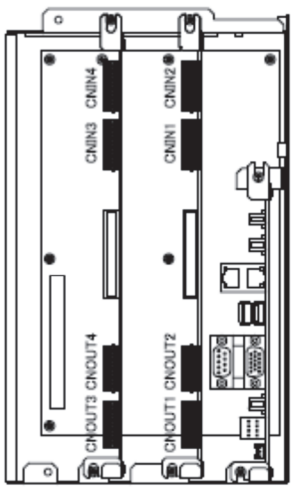
Pin arrangement of Connector CNIN1,2

CNOUT pin arrangement is the view from the soldering side.
Connecter type : MR-50LF (soldering type female connector : Honta Tsushin)

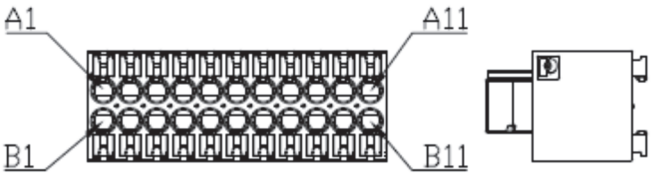


Pin arrangement of Connector CNOUT1,2

Fig. 3.8.2 Pin layout of I/O board connector input signal connector
(in case of FD20-OP125-A/B , FD20-OP151-A/B)

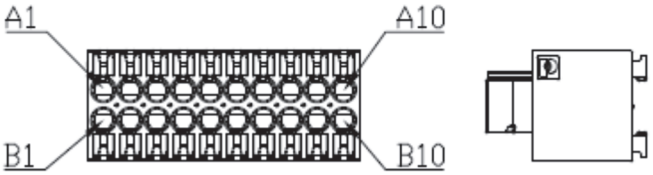


CNIN pin arrangement is the view from the cable inserting side.
Connecter type :DFMC 0,5/11-ST-2,54 (Phoenix contact)



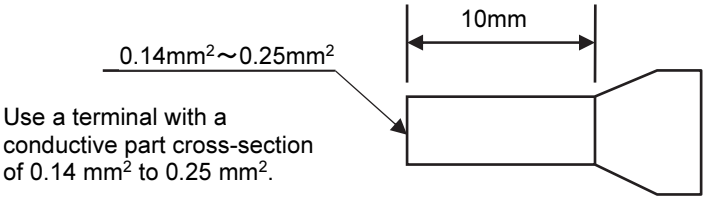
Pin arrangement of Connector CNIN1,2,3,4

CNOUT pin arrangement is the view from the cable inserting side.
Connecter type :DFMC 0,5/10-ST-2,54 (Phoenix contact)

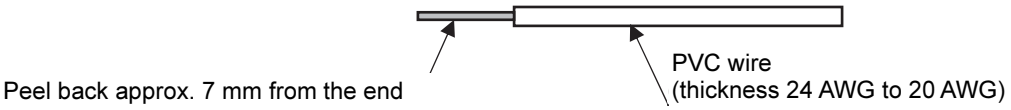


Pin arrangement of Connector CNOUT1,2,3,4

For the signal wire that will be connected to the terminal block, use a bar terminal (conductive part length of 10 mm, cross-section of 0.14 mm^2 to 0.25 mm^2) or a PVC wire (thickness 24 AWG to 20 AWG) with approximately 7 mm of the end peeled off.



<When connecting with a bar terminal>



<When connecting a PVC wire>

Fig. 3.8.3 Pin layout of I/O board connector input signal connector
(in case of FD20-OP125-C/D , FD20-OP151-C/D)

3.8.2.2 Connections to I/O board Input and output Signals

CAUTION

(Note 1) Do not connect different power system signals to the same common. Doing so may cause malfunctions.
(Note 2) Do not connect wires to 28 to 32, 42 to 44 of the terminal block connector.

Table 3.8.6 List of I/O board input signals (CNIN1, 2)
(in case of FD20-OP125-A/B , FD20-OP151-A/B)

	IO board 1-CNIN1			IO board 2-CNIN2		
Connector Pin No.	Signal name	Signal (I*)	Pin description (initial setting)	Signal name	Signal (I*)	Pin description (initial setting)
1	IN1	I1	General-purpose input signal	IN33	I33	General-purpose input signal
2	IN2	I2	General-purpose input signal	IN34	I34	General-purpose input signal
3	IN3	I3	General-purpose input signal	IN35	I35	General-purpose input signal
4	IN4	I4	General-purpose input signal	IN36	I36	General-purpose input signal
5	IN5	I5	General-purpose input signal	IN37	I37	General-purpose input signal
6	IN6	I6	General-purpose input signal	IN38	I38	General-purpose input signal
7	IN7	I7	General-purpose input signal	IN39	I39	General-purpose input signal
8	IN8	I8	General-purpose input signal	IN40	I40	General-purpose input signal
9	IN COM1	Common	Common of IN1~IN8 (Note 1)	IN COM5	Common	Common of IN33~IN40 (Note 1)
10	IN9	I9	General-purpose input signal	IN41	I41	General-purpose input signal
11	IN10	I10	General-purpose input signal	IN42	I42	General-purpose input signal
12	IN11	I11	General-purpose input signal	IN43	I43	General-purpose input signal
13	IN12	I12	General-purpose input signal	IN44	I44	General-purpose input signal
14	IN13	I13	General-purpose input signal	IN45	I45	General-purpose input signal
15	IN14	I14	General-purpose input signal	IN46	I46	General-purpose input signal
16	IN15	I15	General-purpose input signal	IN47	I47	General-purpose input signal
17	IN16	I16	General-purpose input signal	IN48	I48	General-purpose input signal
18	IN COM2	Common	Common of IN9~IN16 (Note 1)	IN COM6	Common	Common of IN41~IN48 (Note 1)
19	IN17	I17	General-purpose input signal	IN49	I49	General-purpose input signal
20	IN18	I18	General-purpose input signal	IN50	I50	General-purpose input signal
21	IN19	I19	General-purpose input signal	IN51	I51	General-purpose input signal
22	IN20	I20	General-purpose input signal	IN52	I52	General-purpose input signal
23	IN21	I21	General-purpose input signal	IN53	I53	General-purpose input signal
24	IN22	I22	General-purpose input signal	IN54	I54	General-purpose input signal
25	IN23	I23	General-purpose input signal	IN55	I55	General-purpose input signal
26	IN24	I24	General-purpose input signal	IN56	I56	General-purpose input signal
27	IN COM3	Common	Common of IN17~IN24 (Note 1)	IN COM7	Common	Common of IN49~IN56 (Note 1)
28～32			Not used (Note 2)			Not used (Note 2)
33	IN25	I9	General-purpose input signal	IN57	I57	General-purpose input signal
34	IN26	I10	General-purpose input signal	IN58	I58	General-purpose input signal
35	IN27	I11	General-purpose input signal	IN59	I59	General-purpose input signal
36	IN28	I12	General-purpose input signal	IN60	I60	General-purpose input signal
37	IN29	I13	General-purpose input signal	IN61	I61	General-purpose input signal
38	IN30	I14	General-purpose input signal	IN62	I62	General-purpose input signal
39	IN31	I15	General-purpose input signal	IN63	I63	General-purpose input signal
40	IN32	I16	General-purpose input signal	IN64	I64	General-purpose input signal
41	IN COM4	Common	Common of IN25~IN32 (Note 1)	IN COM8	Common	Common of IN57~IN64 (Note 1)
42～44			Not used (Note 2)			Not used (Note 2)
45～47	P1	—	Internal 24V	P1	—	Internal 24V
48～50	M1	—	Internal 0V	M1	—	Internal 0V

Table 3.8.7 List of I/O board output signals (CNOUT1, 2)
(in case of FD20-OP125-A/B , FD20-OP151-A/B)

	IO board 1-CNOUT1			IO board 2-CNOUT2		
Connector Pin No.	Signal name	Signal (O*)	Pin description (initial setting)	Signal name	Signal (O*)	Pin description (initial setting)
1	OUT1	O1	General-purpose output signal	OUT33	O33	General-purpose output signal
2	OUT2	O2	General-purpose output signal	OUT34	O34	General-purpose output signal
3	OUT3	O3	General-purpose output signal	OUT35	O35	General-purpose output signal
4	OUT4	O4	General-purpose output signal	OUT36	O36	General-purpose output signal
5	OUT5	O5	General-purpose output signal	OUT37	O37	General-purpose output signal
6	OUT6	O6	General-purpose output signal	OUT38	O38	General-purpose output signal
7	OUT7	O7	General-purpose output signal	OUT39	O39	General-purpose output signal
8	OUT8	O8	General-purpose output signal	OUT40	O40	General-purpose output signal
9	OUT COM1	Common	Common of OUT1~OUT8 (Note 1)	OUT COM5	Common	Common of OUT33~OUT40 (Note 1)
10	OUT9	O9	General-purpose output signal	OUT41	O41	General-purpose output signal
11	OUT10	O10	General-purpose output signal	OUT42	O42	General-purpose output signal
12	OUT11	O11	General-purpose output signal	OUT43	O43	General-purpose output signal
13	OUT12	O12	General-purpose output signal	OUT44	O44	General-purpose output signal
14	OUT13	O13	General-purpose output signal	OUT45	O45	General-purpose output signal
15	OUT14	O14	General-purpose output signal	OUT46	O46	General-purpose output signal
16	OUT15	O15	General-purpose output signal	OUT47	O47	General-purpose output signal
17	OUT16	O16	General-purpose output signal	OUT48	O48	General-purpose output signal
18	OUT COM2	Common	Common of OUT9~OUT16 (Note 1)	OUT COM6	Common	Common of OUT41~OUT48 (Note 1)
19	OUT17	O17	General-purpose output signal	OUT49	O49	General-purpose output signal
20	OUT18	O18	General-purpose output signal	OUT50	O50	General-purpose output signal
21	OUT19	O19	General-purpose output signal	OUT51	O51	General-purpose output signal
22	OUT20	O20	General-purpose output signal	OUT52	O52	General-purpose output signal
23	OUT21	O21	General-purpose output signal	OUT53	O53	General-purpose output signal
24	OUT22	O22	General-purpose output signal	OUT54	O54	General-purpose output signal
25	OUT23	O23	General-purpose output signal	OUT55	O55	General-purpose output signal
26	OUT24	O24	General-purpose output signal	OUT56	O56	General-purpose output signal
27	OUT COM3	Common	Common of OUT17~OUT24 (Note 1)	OUT COM7	Common	Common of OUT49~OUT56 (Note 1)
28～32			Not used (Note 2)			Not used (Note 2)
33	OUT25	O9	General-purpose output signal	OUT57	O57	General-purpose output signal
34	OUT26	O10	General-purpose output signal	OUT58	O58	General-purpose output signal
35	OUT27	O11	General-purpose output signal	OUT59	O59	General-purpose output signal
36	OUT28	O12	General-purpose output signal	OUT60	O60	General-purpose output signal
37	OUT29	O13	General-purpose output signal	OUT61	O61	General-purpose output signal
38	OUT30	O14	General-purpose output signal	OUT62	O62	General-purpose output signal
39	OUT31	O15	General-purpose output signal	OUT63	O63	General-purpose output signal
40	OUT32	O16	General-purpose output signal	OUT64	O64	General-purpose output signal
41	OUT COM4	Common	Common of OUT25~OUT32 (Note 1)	OUT COM8	Common	Common of OUT57~OUT64 (Note 1)
42～44			Not used (Note 2)			Not used (Note 2)
45～47	P1	—	Internal power 24V	P1	—	Internal power 24V
48～50	M1	—	Internal power 0V	M1	—	Internal power 0V

Table 3.8.8 List of I/O board input signals (CNIN1, 2, 3, 4)
(in case of FD20-OP125-C/D , FD20-OP151-C/D)

	IO board 1-CNIN1			IO board 1-CNIN2		
Connector Pin No.	Signal name	Signal (I*)	Pin description (initial setting)	Signal name	Signal (I*)	Pin description (initial setting)
A1	IN1	I1	General-purpose input signal	IN17	I17	General-purpose input signal
A2	IN2	I2	General-purpose input signal	IN18	I18	General-purpose input signal
A3	IN3	I3	General-purpose input signal	IN19	I19	General-purpose input signal
A4	IN4	I4	General-purpose input signal	IN20	I20	General-purpose input signal
A5	IN5	I5	General-purpose input signal	IN21	I21	General-purpose input signal
A6	IN6	I6	General-purpose input signal	IN22	I22	General-purpose input signal
A7	IN7	I7	General-purpose input signal	IN23	I23	General-purpose input signal
A8	IN8	I8	General-purpose input signal	IN24	I24	General-purpose input signal
A9	IN COM1	Common	Common of IN1~IN8 (Note 1)	IN COM3	Common	Common of IN17~IN24 (Note 1)
A10	P1	—	Internal 24V	P1	-	Internal 24V
A11	P1	—	Internal 24V	P1	-	Internal 24V
B1	IN9	I9	General-purpose input signal	IN25	I25	General-purpose input signal
B2	IN10	I10	General-purpose input signal	IN26	I26	General-purpose input signal
B3	IN11	I11	General-purpose input signal	IN27	I27	General-purpose input signal
B4	IN12	I12	General-purpose input signal	IN28	I28	General-purpose input signal
B5	IN13	I13	General-purpose input signal	IN29	I29	General-purpose input signal
B6	IN14	I14	General-purpose input signal	IN30	I30	General-purpose input signal
B7	IN15	I15	General-purpose input signal	IN31	I31	General-purpose input signal
B8	IN16	I16	General-purpose input signal	IN32	I32	General-purpose input signal
B9	IN COM2	Common	Common of IN9~IN16 (Note 1)	IN COM4	Common	Common of IN25~IN32 (Note 1)
B10	M1	—	Internal 0V	M1	—	Internal 0V
B11	M1	—	Internal 0V	M1	—	Internal 0V

	IO board 2-CNIN3			IO board 2-CNIN4		
Connector Pin No.	Signal name	Signal (I*)	Pin description (initial setting)	Signal name	Signal (I*)	Pin description (initial setting)
A1	IN33	I33	General-purpose input signal	IN49	I49	General-purpose input signal
A2	IN34	I34	General-purpose input signal	IN50	I50	General-purpose input signal
A3	IN35	I35	General-purpose input signal	IN51	I51	General-purpose input signal
A4	IN36	I36	General-purpose input signal	IN52	I52	General-purpose input signal
A5	IN37	I37	General-purpose input signal	IN53	I53	General-purpose input signal
A6	IN38	I38	General-purpose input signal	IN54	I54	General-purpose input signal
A7	IN39	I39	General-purpose input signal	IN55	I55	General-purpose input signal
A8	IN40	I40	General-purpose input signal	IN56	I56	General-purpose input signal
A9	IN COM5	Common	Common of IN33~IN49 (Note 1)	IN COM7	Common	Common of IN49~IN56 (Note 1)
A10	P1	-	Internal 24V	P1	-	Internal 24V
A11	P1	-	Internal 24V	P1	-	Internal 24V
B1	IN41	I41	General-purpose input signal	IN57	I57	General-purpose input signal
B2	IN42	I42	General-purpose input signal	IN58	I58	General-purpose input signal
B3	IN43	I43	General-purpose input signal	IN59	I59	General-purpose input signal
B4	IN44	I44	General-purpose input signal	IN60	I60	General-purpose input signal
B5	IN45	I45	General-purpose input signal	IN61	I61	General-purpose input signal
B6	IN46	I46	General-purpose input signal	IN62	I62	General-purpose input signal
B7	IN47	I47	General-purpose input signal	IN63	I63	General-purpose input signal
B8	IN48	I48	General-purpose input signal	IN64	I64	General-purpose input signal
B9	IN COM6	Common	Common of IN41~IN48 (Note 1)	IN COM8	Common	Common of IN57~IN64 (Note 1)
B10	M1	—	Internal 0V	M1	—	Internal 0V
B11	M1	—	Internal 0V	M1	—	Internal 0V

Table 3.8.9 List of I/O board output signals (CNOUT1, 2, 3, 4)
(in case of FD20-OP125-C/D , FD20-OP151-C/D)

	IO board 1-CNOUT1			IO board 1-CNOUT2		
Connector Pin No.	Signal name	Signal (O*)	Pin description (initial setting)	Signal name	Signal (O*)	Pin description (initial setting)
A1	OUT1	O1	General-purpose output signal	OUT17	O17	General-purpose output signal
A2	OUT2	O2	General-purpose output signal	OUT18	O18	General-purpose output signal
A3	OUT3	O3	General-purpose output signal	OUT19	O19	General-purpose output signal
A4	OUT4	O4	General-purpose output signal	OUT20	O20	General-purpose output signal
A5	OUT5	O5	General-purpose output signal	OUT21	O21	General-purpose output signal
A6	OUT6	O6	General-purpose output signal	OUT22	O22	General-purpose output signal
A7	OUT7	O7	General-purpose output signal	OUT23	O23	General-purpose output signal
A8	OUT8	O8	General-purpose output signal	OUT24	O24	General-purpose output signal
A9	OUT COM1	Common	Common of OUT1~OUT8 (Note 1)	OUT COM3	Common	Common of OUT17~OUT24 (Note 1)
A10	P1	—	Internal power 24V	P1	—	Internal power 24V
B1	OUT9	O9	General-purpose output signal	OUT25	O9	General-purpose output signal
B2	OUT10	O10	General-purpose output signal	OUT26	O10	General-purpose output signal
B3	OUT11	O11	General-purpose output signal	OUT27	O11	General-purpose output signal
B4	OUT12	O12	General-purpose output signal	OUT28	O12	General-purpose output signal
B5	OUT13	O13	General-purpose output signal	OUT29	O13	General-purpose output signal
B6	OUT14	O14	General-purpose output signal	OUT30	O14	General-purpose output signal
B7	OUT15	O15	General-purpose output signal	OUT31	O15	General-purpose output signal
B8	OUT16	O16	General-purpose output signal	OUT32	O16	General-purpose output signal
B9	OUT COM2	Common	Common of OUT9~OUT16 (Note 1)	OUT COM4	Common	Common of OUT25~OUT32 (Note 1)
B10	M1	—	Internal power 0V	M1	—	Internal power 0V

	IO board 2-CNOUT3			IO board 2-CNOUT4		
Connector Pin No.	Signal name	Signal (O*)	Pin description (initial setting)	Signal name	Signal (O*)	Pin description (initial setting)
A1	OUT33	O33	General-purpose output signal	OUT49	O49	General-purpose output signal
A2	OUT34	O34	General-purpose output signal	OUT50	O50	General-purpose output signal
A3	OUT35	O35	General-purpose output signal	OUT51	O51	General-purpose output signal
A4	OUT36	O36	General-purpose output signal	OUT52	O52	General-purpose output signal
A5	OUT37	O37	General-purpose output signal	OUT53	O53	General-purpose output signal
A6	OUT38	O38	General-purpose output signal	OUT54	O54	General-purpose output signal
A7	OUT39	O39	General-purpose output signal	OUT55	O55	General-purpose output signal
A8	OUT40	O40	General-purpose output signal	OUT56	O56	General-purpose output signal
A9	OUT COM5	Common	Common of OUT33~OUT40 (Note 1)	OUT COM7	Common	Common of OUT49~OUT56 (Note 1)
A10	P1	—	Internal power 24V	P1	—	Internal power 24V
B1	OUT41	O41	General-purpose output signal	OUT57	O57	General-purpose output signal
B2	OUT42	O42	General-purpose output signal	OUT58	O58	General-purpose output signal
B3	OUT43	O43	General-purpose output signal	OUT59	O59	General-purpose output signal
B4	OUT44	O44	General-purpose output signal	OUT60	O60	General-purpose output signal
B5	OUT45	O45	General-purpose output signal	OUT61	O61	General-purpose output signal
B6	OUT46	O46	General-purpose output signal	OUT62	O62	General-purpose output signal
B7	OUT47	O47	General-purpose output signal	OUT63	O63	General-purpose output signal
B8	OUT48	O48	General-purpose output signal	OUT64	O64	General-purpose output signal
B9	OUT COM6	Common	Common of OUT41~OUT48 (Note 1)	OUT COM8	Common	Common of OUT57~OUT64 (Note 1)
B10	M1	—	Internal power 0V	M1	—	Internal power 0V

3.8.2.3 Connections to I/O board

A connection example to I/O board is shown below.

For details on the electrical specifications, see p3-30 “3.8.1 Common items”.

CAUTION

- Be absolutely sure to use a surge killer for the load.
- Do not use power with the wrong polarity.

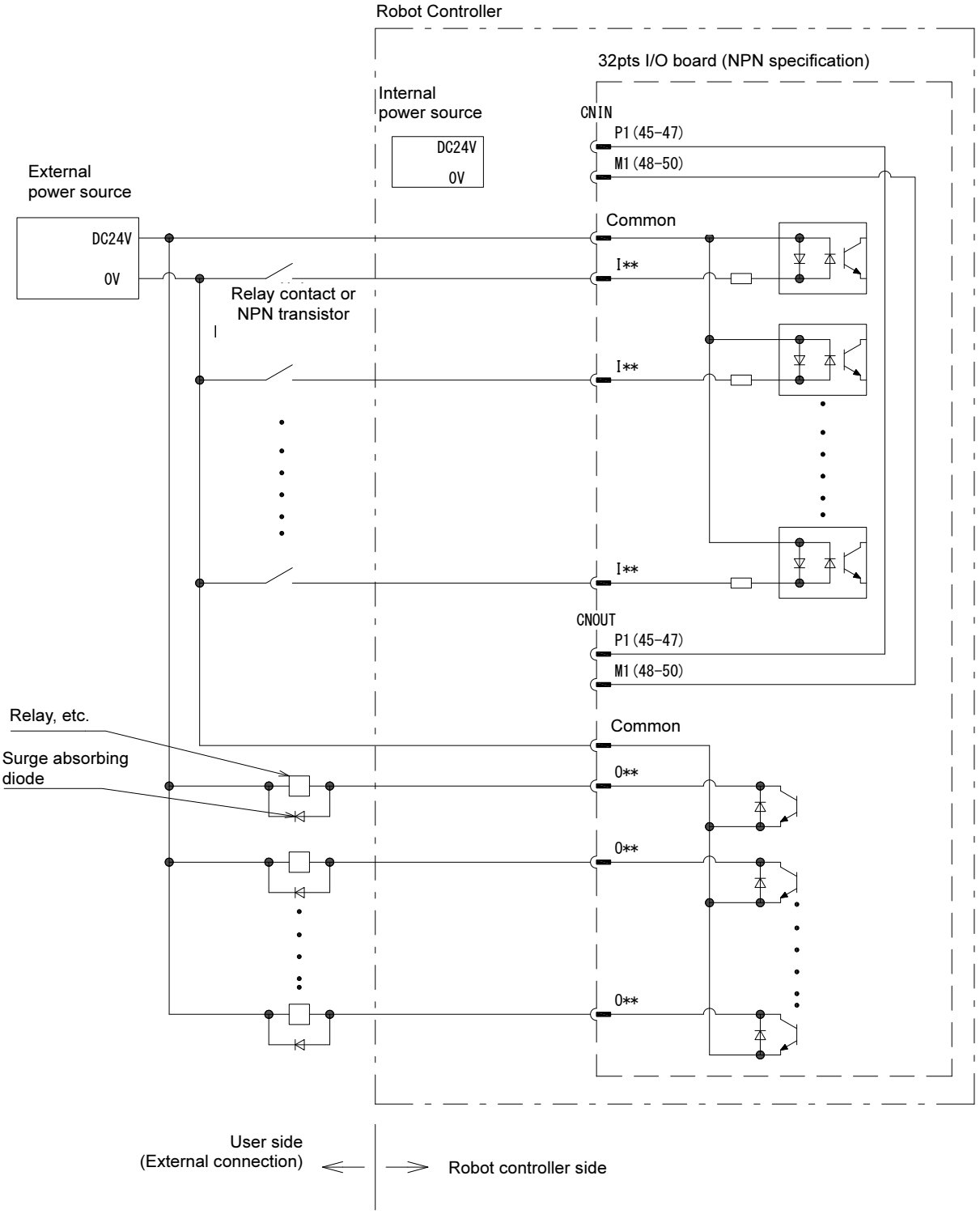


Fig. 3.8.4 Input and output Circuit of I/O board with External power source (NPN)

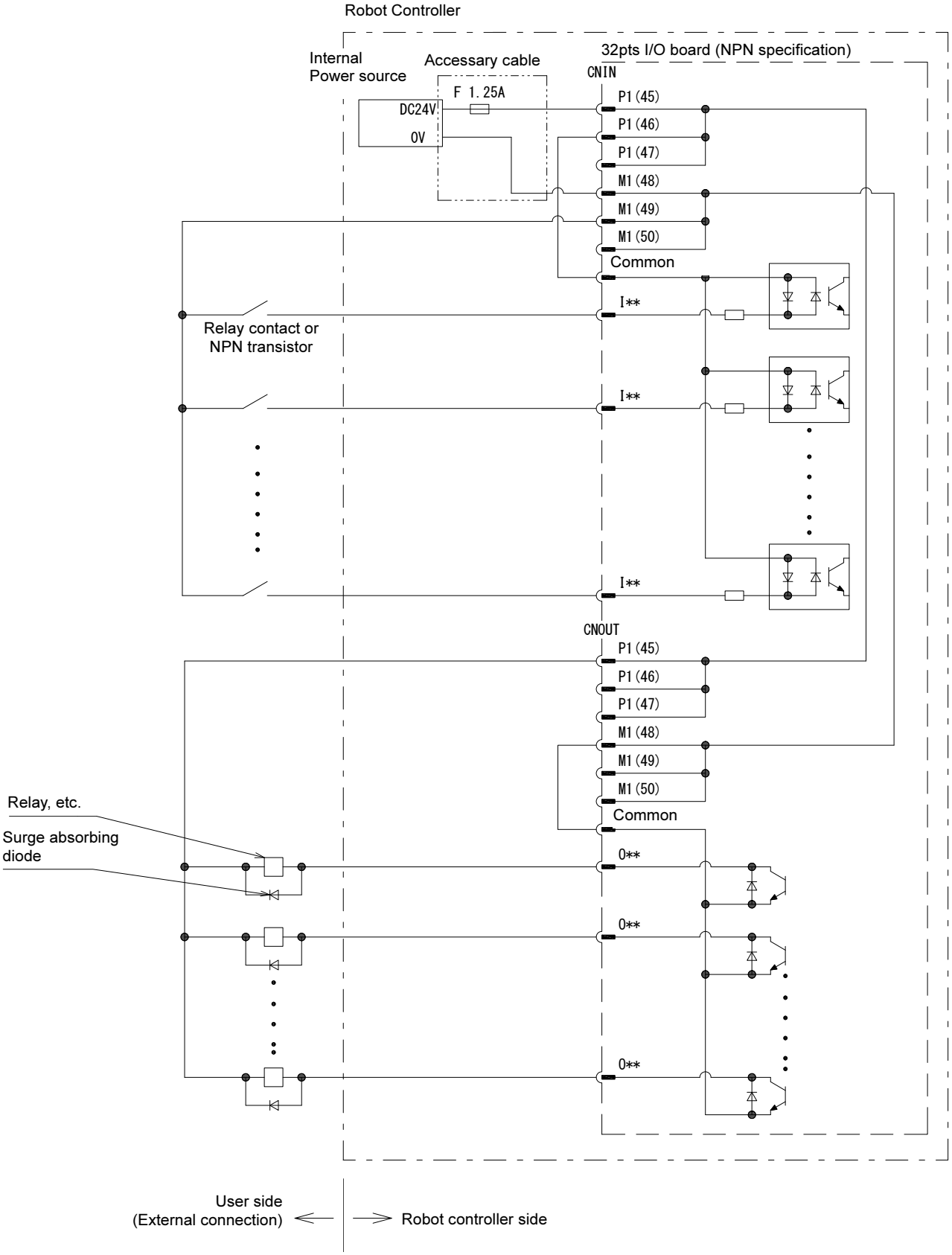


Fig. 3.8.5 Input and output Circuit of I/O board with Internal power source (NPN)

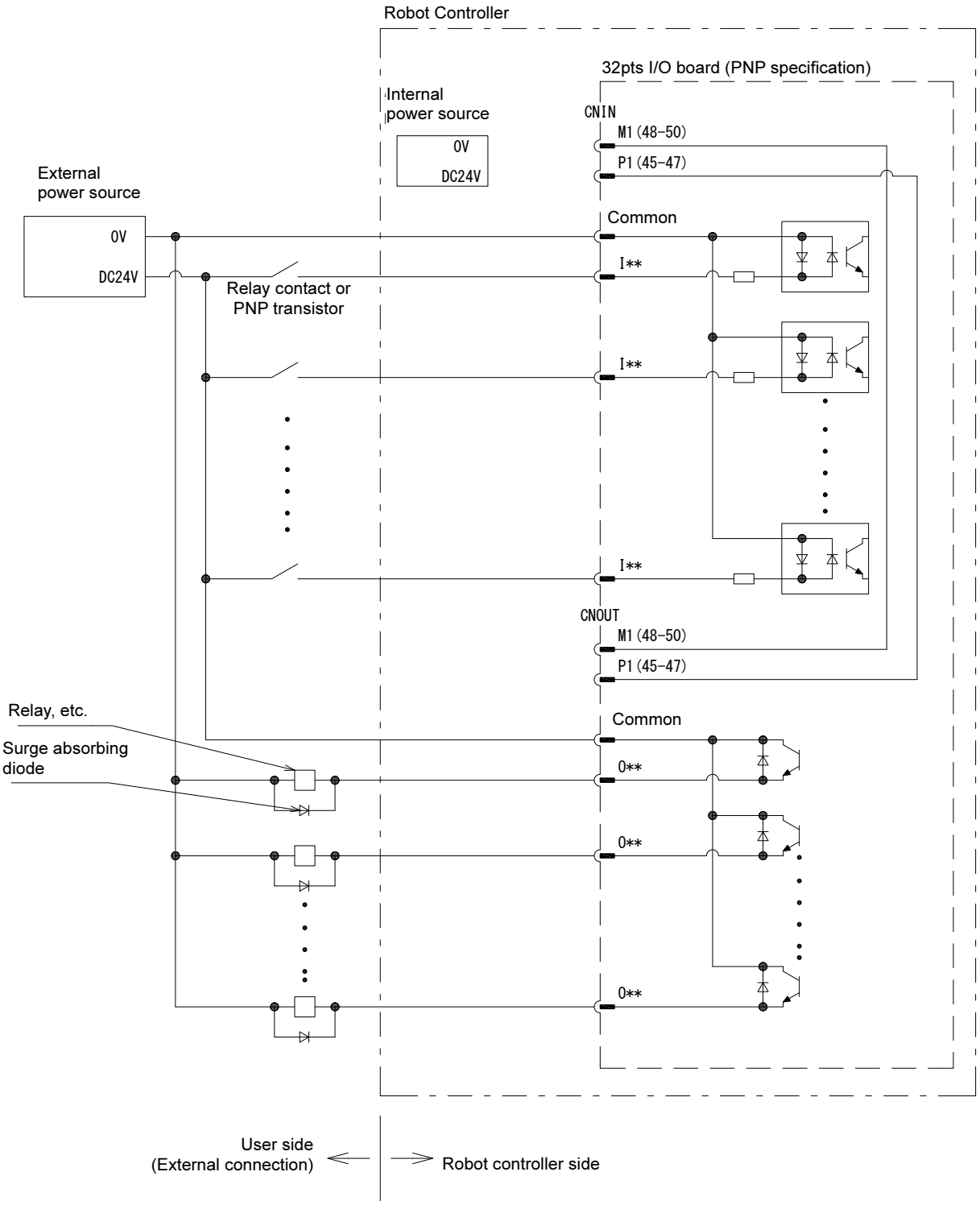


Fig. 3.8.6 Input and output Circuit of I/O board with External power source (PNP)

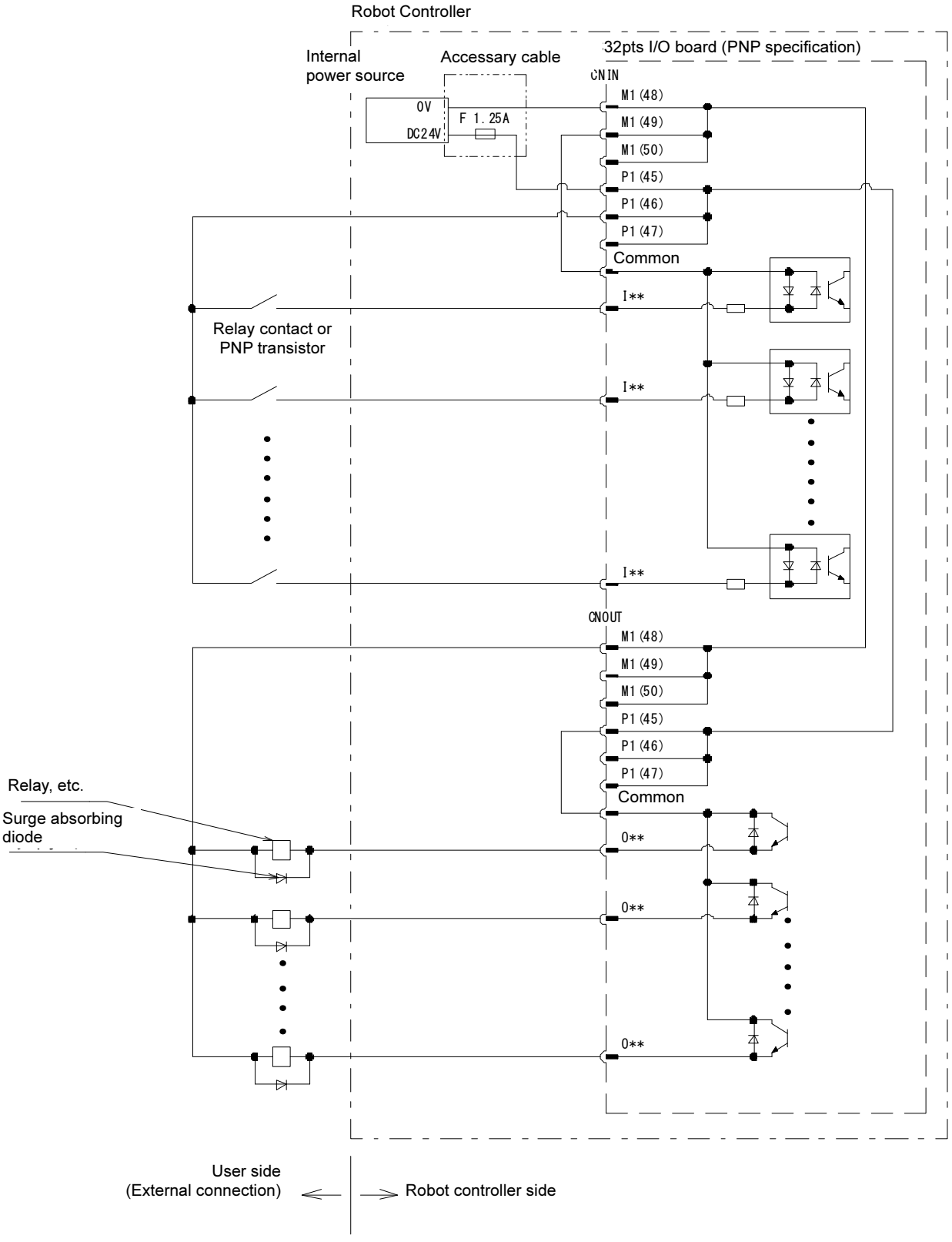
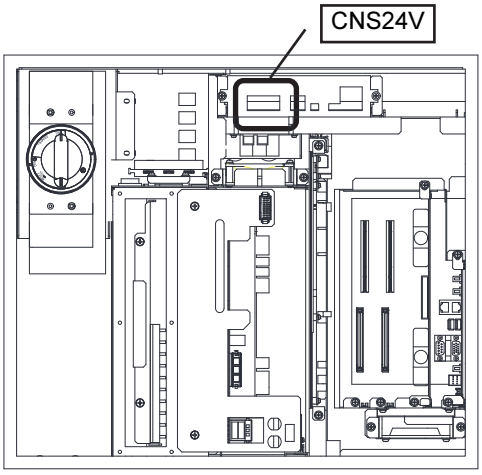


Fig. 3.8.7 Input and output Circuit of I/O board with Internal power source (PNP)

3.8.2.4 Internal power source connection to the I/O Board

When internal power source is used for I/O board, supply the power from CNS24V of multi power unit with using power cable which comes with I/O board option.



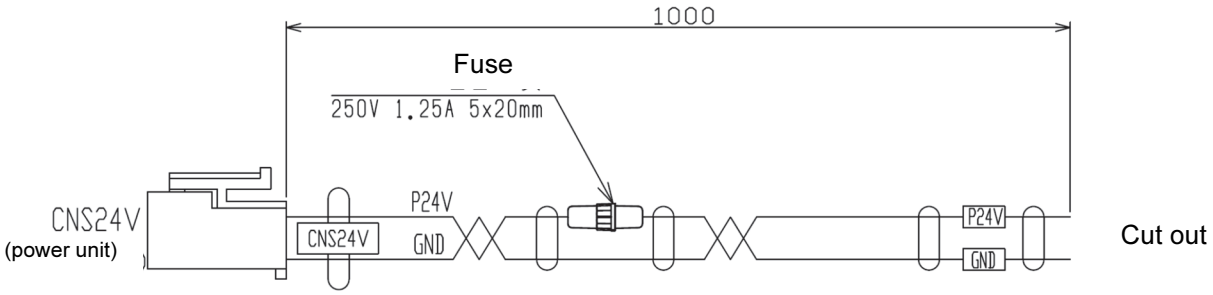


Fig. 3.8.8 Accessary power cable

3.8.3 Signal specifications of Mini I/O option

Refer to the sections shown in Table 3.8.5 according to the DC24V supply method.
For details of the initial settings of signal allocations, refer also to “4.6.2 Basic input signals” and “4.6.3 Basic output signals”.

Table 3.8.10 When using External DC24V Power Supply

Output type	I/O type	Connector number	Reference	
			I/O signal specifications	Connection procedure
Semiconductor output	Input	TBX1	p3-44 Table 3.8.12	p3-46 Section 3.8.3.4
	Output	TBX1		
Relay Output	Input	TBX1	p3-45 Table 3.8.13	p3-48 Section 3.8.3.6
	Output	TBX1		

Table 3.8.11 When using Internal DC24V Power Supply

Output type	I/O type	Connector number	Reference	
			I/O signal specifications	Connection procedure
Semiconductor output	Input	TBX1	p3-44 Table 3.8.12	p3-47 Section 3.8.3.5
	Output	TBX1		
Relay Output	Input	TBX1	p3-45 Table 3.8.13	p3-49 Section 3.8.3.7
	Output	TBX1		

3.8.3.1 Terminal block connector TBX1 of Mini I/O option

The Mini I/O option has signal connection terminals of 14 general-purpose inputs and 10 general-purpose outputs.

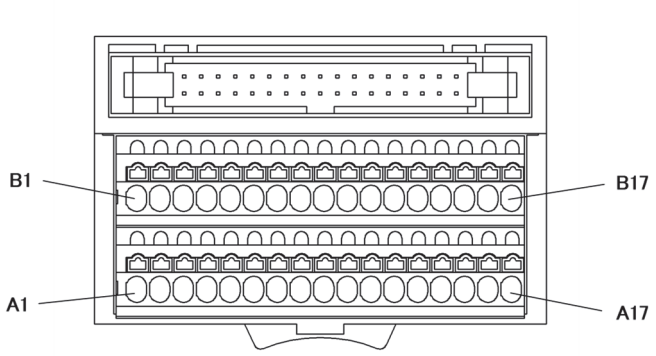


Fig. 3.8.9 Mini I/O option terminal block connector pin layout

3.8.3.2 I/O specification of Mini I/O option (semiconductor output)

CAUTION

(Note 1) Do not connect different power system signals to the same common. Doing so may cause malfunctions.
(Note 2) Do not connect external power to the pin of internal power source.
(Note 3) Do not connect any wire to B15 of the terminal block connector.

Table 3.8.12 List of signals of Mini I/O option (TBX1)

Terminal block pin number	Signal name	Description of terminal (initial allocation)
A1	GP_IN1	General-purpose input signal
A2	GP_IN2	General-purpose input signal
A3	GP_IN3	General-purpose input signal
A4	GP_IN4	General-purpose input signal
A5	GP_IN5	General-purpose input signal
A6	GP_IN6	General-purpose input signal
A7	GP_IN7	General-purpose input signal
A8	GP_IN8	General-purpose input signal
A9	GP_IN9	General-purpose input signal
A10	GP_IN10	General-purpose input signal
A11	GP_IN11	General-purpose input signal
A12	GP_IN13	General-purpose input signal
A13	IN_COM1	Common for pins A1 to A6 (GP_IN1 to GP_IN6) (Note 1)
A14	IN_COM2	Common for pins A7 to A10 (GP_IN7 to GP_IN10) (Note 1)
A15	IN_COM3	Common for pins A11, B11, A12 and B12 (GP_IN11 to GP_IN14) (Note 1)
A16	U24V	Internal power source DC24V (Note 2)
A17	U24V	Internal power source DC24V (Note 2)
B1	GP_OUT1	General-purpose output signal
B2	GP_OUT2	General-purpose output signal
B3	GP_OUT3	General-purpose output signal
B4	GP_OUT4	General-purpose output signal
B5	GP_OUT5	General-purpose output signal
B6	GP_OUT6	General-purpose output signal
B7	GP_OUT7	General-purpose output signal
B8	GP_OUT8	General-purpose output signal
B9	GP_OUT9	General-purpose output signal
B10	GP_OUT10	General-purpose output signal
B11	GP_IN12	General-purpose input signal
B12	GP_IN14	General-purpose input signal
B13	OUT_COM1	Common for pins B1 to B6 (GP_OUT1 to GP_OUT6) (Note 1)
B14	OUT_COM2	Common for pins B7 to B10 (GP_OUT7 to GP_OUT10) (Note 1)
B15	-	Not used (Note 3)
B16	U0V	Internal power source GND (Note 2)
B17	U0V	Internal power source GND (Note 2)

3.8.3.3 I/O specification of Mini I/O option (relay output)

CAUTION

(Note 1) Do not connect different power system signals to the same common. Doing so may cause malfunctions.
(Note 2) Do not connect external power to the pin of internal power source.
(Note 3) Do not connect wires to A15-A17, B9-B10, 12 and 15-17 of the terminal block connector.

Table 3.8.13 List of signals of Mini I/O option [Relay output spec.] (TBX1)

Terminal block pin number	Signal name	Description of terminal (initial allocation)
A1	GP_IN1	General-purpose input signal
A2	GP_IN2	General-purpose input signal
A3	GP_IN3	General-purpose input signal
A4	GP_IN4	General-purpose input signal
A5	GP_IN5	General-purpose input signal
A6	GP_IN6	General-purpose input signal
A7	GP_IN7	General-purpose input signal
A8	GP_IN8	General-purpose input signal
A9	GP_IN9	General-purpose input signal
A10	GP_IN10	General-purpose input signal
A11	IN_COM1	Common for pins A1 to A6 (GP_IN1 to GP_IN6) (Note 1)
A12	IN_COM2	Common for pins A7 to A10 (GP_IN7 to GP_IN10) (Note 1)
A13	U24V	Internal power source DC24V (Note 2)
A14	U24V	Internal power source DC24V (Note 2)
A15	-	Not used (Note 3)
A16	-	Not used (Note 3)
A17	-	Not used (Note 3)
B1	GP_OUT1	General-purpose output signal
B2	GP_OUT2	General-purpose output signal
B3	GP_OUT3	General-purpose output signal
B4	GP_OUT4	General-purpose output signal
B5	GP_OUT5	General-purpose output signal
B6	GP_OUT6	General-purpose output signal
B7	GP_OUT7	General-purpose output signal
B8	GP_OUT8	General-purpose output signal
B9	-	Not used (Note 3)
B10	-	Not used (Note 3)
B11	OUT_COM1	Common for pins B1 to B8 (GP_OUT1 to GP_OUT8) (Note 1)
B12	-	Not used (Note 3)
B13	U0V	Internal power source GND (Note 2)
B14	U0V	Internal power source GND (Note 2)
B15	-	Not used (Note 3)
B16	-	Not used (Note 3)
B17	-	Not used (Note 3)

3.8.3.4 Connection Input and output signals to Mini I/O option (DC24V external power, semiconductor output spec.)

For details on the electrical specifications,
see “3.8.1.2 Electrical specifications of physical input” on page 3-30 for the input signals,
see “3.8.1.3 Electrical specifications of physical output” on page 3-31 for the output signals.

- Be absolutely sure to use a surge killer for the load.
- Do not use power with the wrong polarity.

A connection example to Mini I/O board input and output signals is shown below.

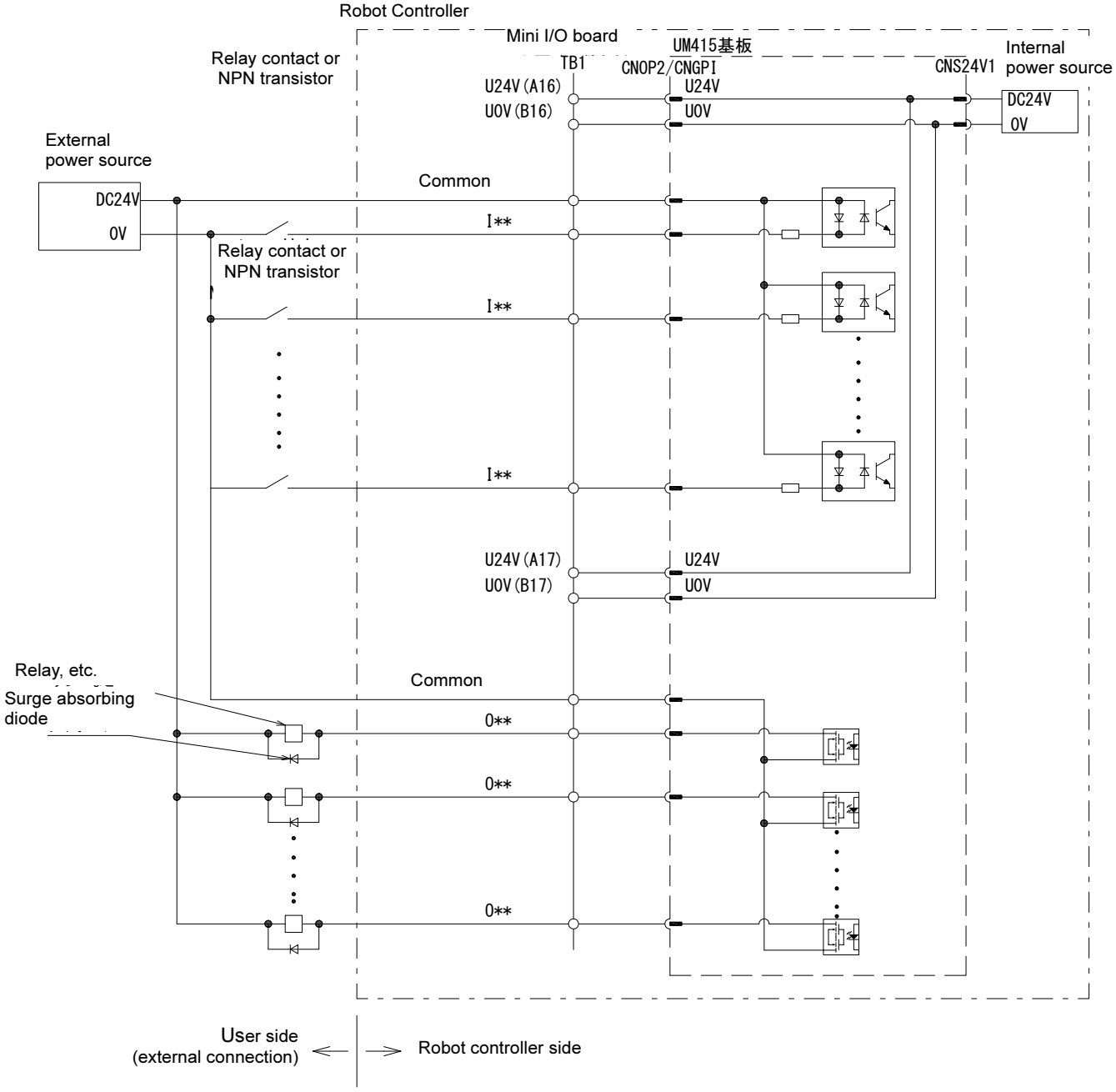


Fig. 3.8.10 Input and output circuit of Mini I/O [semiconductor output specification]
(When DC24V is supplied from external power source)

3.8.3.5 Connection Input and output signals to Mini I/O option (DC24V internal power, semiconductor output spec.)

INFO.

・For details on the electrical specifications,
see “3.8.1.2 Electrical specifications of physical input” on page 3-30 for the input signals,
see “3.8.1.3 Electrical specifications of physical output” on page 3-31 for the output signals.
・For details on the electrical specifications of internal power source,
see “3.8.1.1 DC24V supplying procedure” on page 3-30.

CAUTION

・Be absolutely sure to use a surge killer for the load.
・Do not use power with the wrong polarity.

A connection example to Mini I/O board input and output signals is shown below.

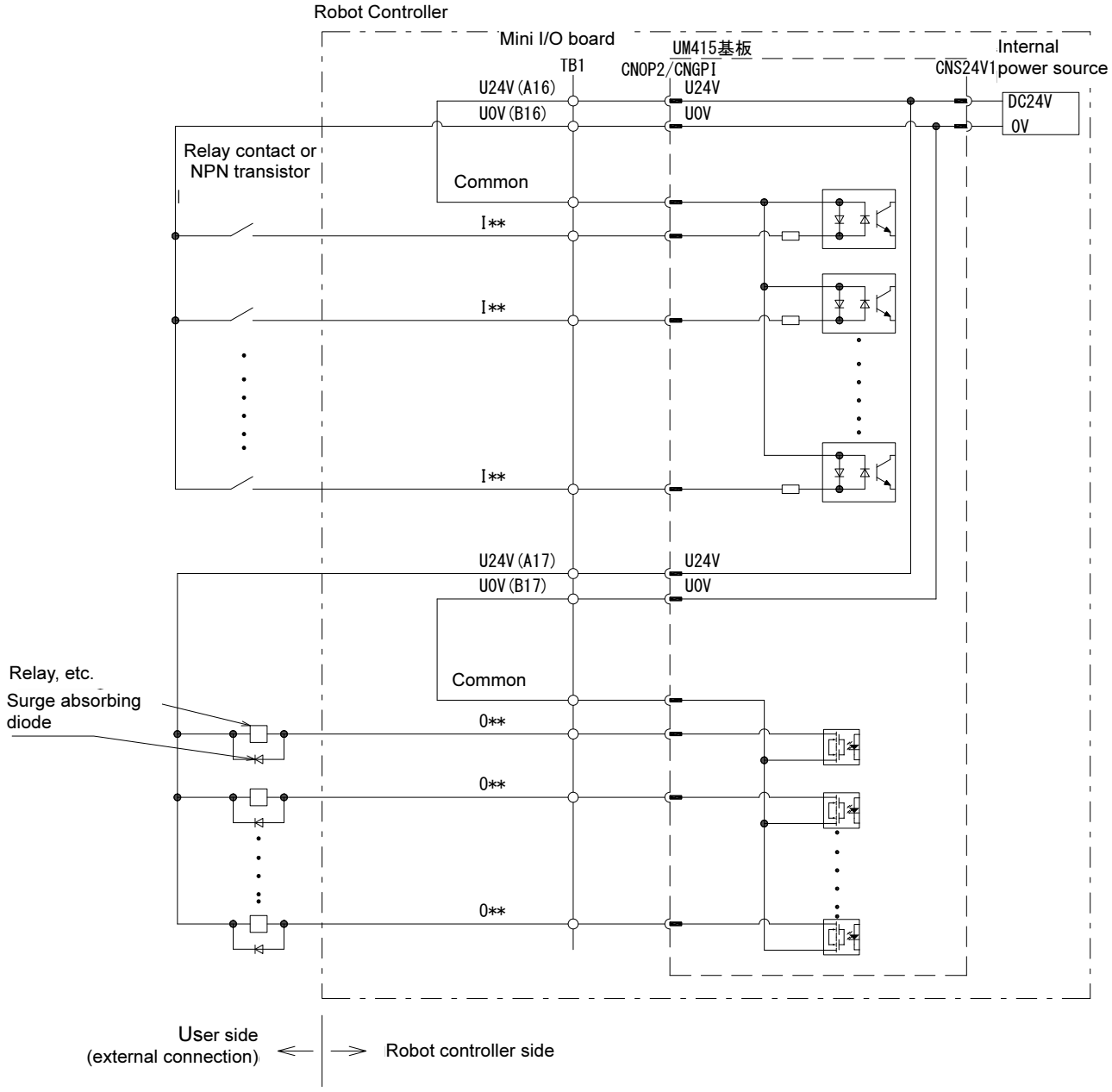


Fig. 3.8.11 Input and output circuit of Mini I/O [semiconductor output specification]
(When DC24V is supplied from internal power source)

3.8.3.6 Connection Input and output signals to Mini I/O option (DC24V external power, relay output spec.)

For details on the electrical specifications,
see “3.8.1.2 Electrical specifications of physical input” on page 3-30 for the input signals,
see “3.8.1.3 Electrical specifications of physical output” on page 3-31 for the output signals.

・Be absolutely sure to use a surge killer for the load.
・Do not use power with the wrong polarity.

A connection example to Mini I/O board input and output signals is shown below.

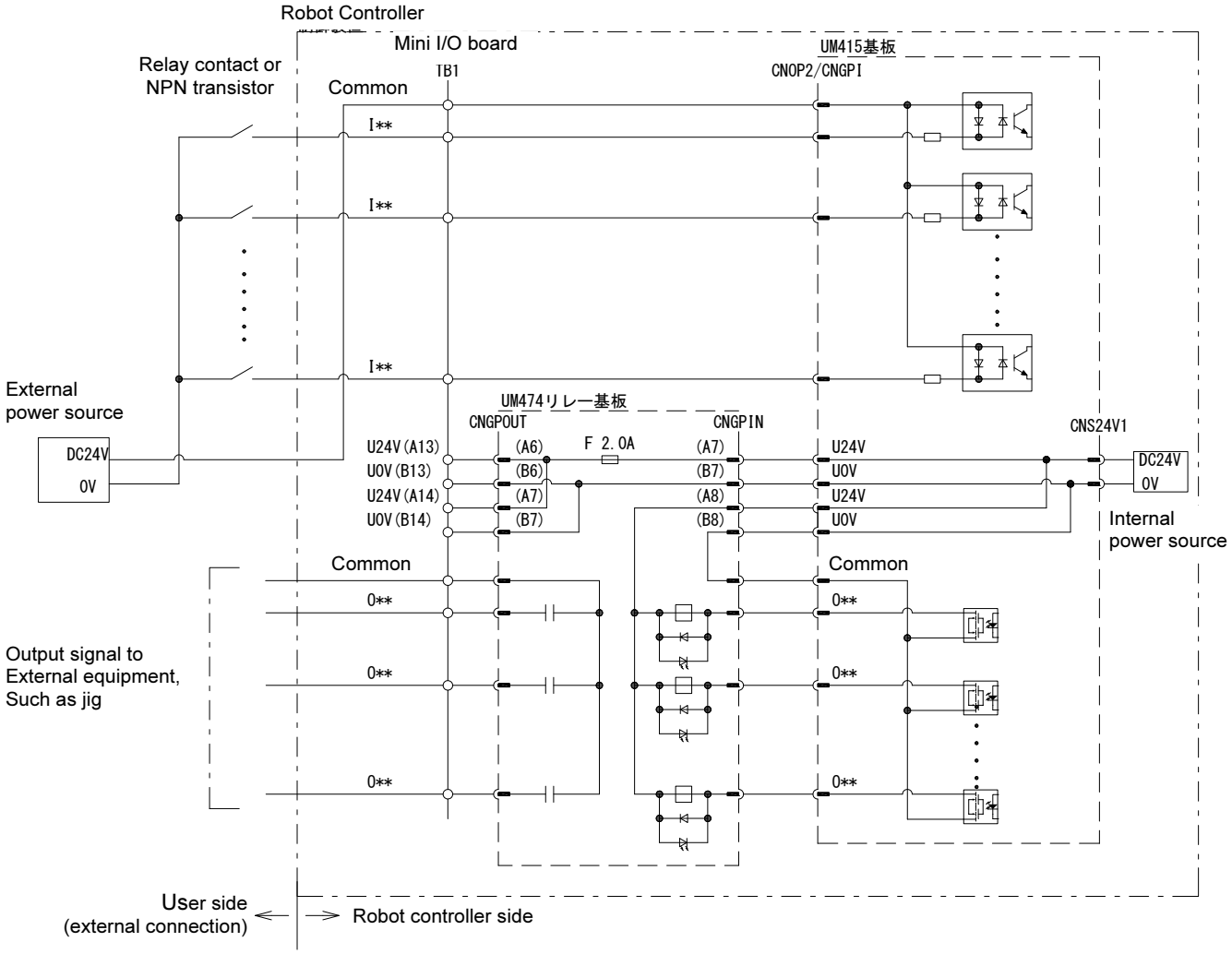


Fig. 3.8.12 Input and output circuit of Mini I/O [Relay output specification]
(When DC24V is supplied from external power source)

3.8.3.7 Connection Input and output signals to Mini I/O option (DC24V Internal power, relay output spec.)

・For details on the electrical specifications,
see “3.8.1.2 Electrical specifications of physical input” on page 3-30 for the input signals,
see “3.8.1.3 Electrical specifications of physical output” on page 3-31 for the output signals.
・For details on the electrical specifications of internal power source,
see “3.8.1.1 DC24V supplying procedure” on page 3-30.

・Be absolutely sure to use a surge killer for the load.
・Do not use power with the wrong polarity.

A connection example to Mini I/O board input and output signals is shown below.

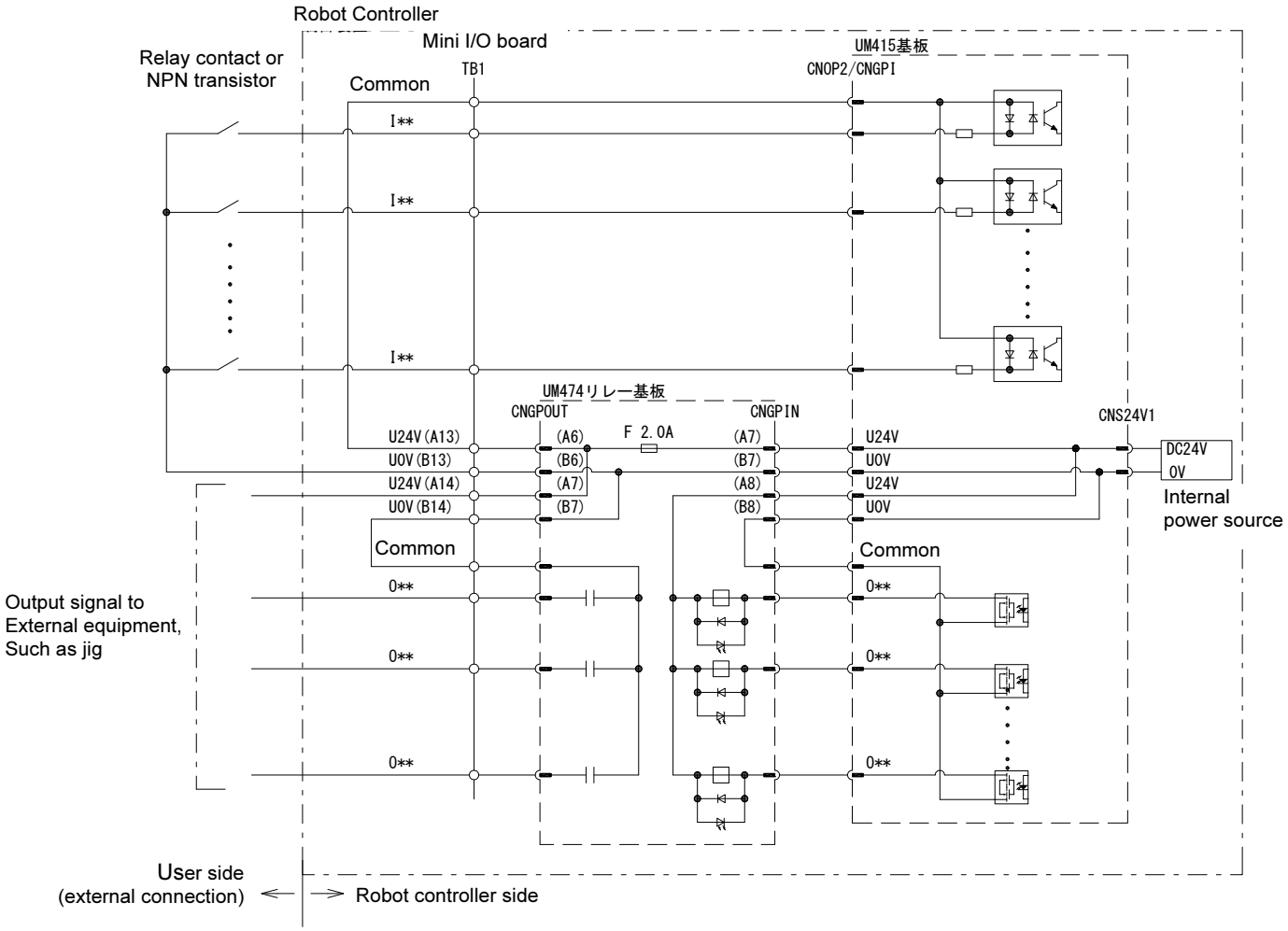


Fig. 3.8.13 Input and output circuit of Mini I/O [Relay output specification]
(When DC24V is supplied from Internal power)

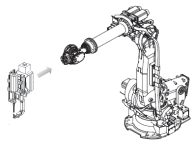
NOTE

Chapter 4 Setup

This chapter describes the preparations performed up to the stage where teaching can be performed for the robot. Setting the tool length and weight and allocating the I/O signals for connection with the peripheral devices are absolutely essential when the robot is to be used. Acquire a thorough understanding of the information contained in this chapter and proceed with the setup.

4.1 How to read “Chapter 4 Setup”

In chapter 4, the outline of the basic setup work (From the robot installation to the start of the teaching work) is described. Perform the setup procedures by referring to the flow chart shown as below



START

Power ON
Motors ON

Refer to the instruction manual "BASIC OPERATIONS MANUAL",

Installing a tool

☞ 4.3 Installing a tool

Adjusting the reference position of each robot axis

☞ 4.3.2 Performing encoder reset and encoder correction

The "tool constants" refer to a set of parameters including the length, angle, center of gravity, weight and moment of inertia of the installed tool. These parameters are extremely important for ensuring precise linear operations and appropriate acceleration / deceleration control. Therefore, do not forget to set these parameters.

Set the tool constants
The settings can be done easily by using

menu.

☞ 4.5 Tool constant settings

- When a servo gun is installed when being shipped; the tool setting is already finished.

This is a procedure in which the I/O signals to be used are assigned. When using the robot with a default setting, it is not necessary to change the settings.

Setup the input / output signals

☞ 4.6 Standard signal attributes assignment

When using software PLC, refer to the operating manual “Software PLC”

To use the robot safely, adjust the sensitivity of the interference detection. And, the software limit should be changed when the mechanical stopper position is changed.

Setup the robot so that it can be used safely

☞ 4.9 High Speed Interference Detection
☞ 4.12 Setting the software limit (operating range)

Optimizing the layout of the f-keys and assigning the exclusive key for the application type. When using the robot with a default setting, it is not necessary to change the settings.

Optimizing the operation key settings

☞ 4.10 Setting the application type
☞ 4.11 Setting the [CLAMP / ARC] key

E N D

Now the basic setup work is finished. Please start the teaching operation.
In case of spot welding application, proceed with the setup work by referring to chapter 5 and by referring to respective “APPLICATION MANUAL“.

Fig. 4.1.1 Overview of basic setup work

4.2 Configuration

4.2.1 Setting of the installation angle of the robot

Depending on the installation angle of the robot, it is necessary to modify the installation angle setting in the <Constant Setting> menu before starting the setup procedures. Also, for details, see the following manual.

"FD20 Controller Instruction Manual: Memory format procedure" (FD20-EN-094).

CAUTION

The setting of the installation angle is used for the calculation of gravity direction in the robot control logic. If this setting is incorrect, the motor torque is not calculated correctly and results in unexpected damage of the motors or the reduction gears inside the robot. Please be sure that the installation angle setting must be done correctly without fail.

If robot is used with wrong installation angle setting, robot is out pf guarantee.

INFO.

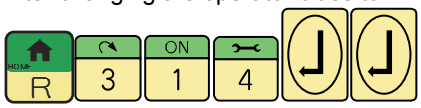
Concerning the setup of the coordinate system for the manual operation, refer to ***"FD20 Controller Instruction Manual: BASIC OPERATIONS" (FD20-EN-002)*** Chapter3.

INFO.

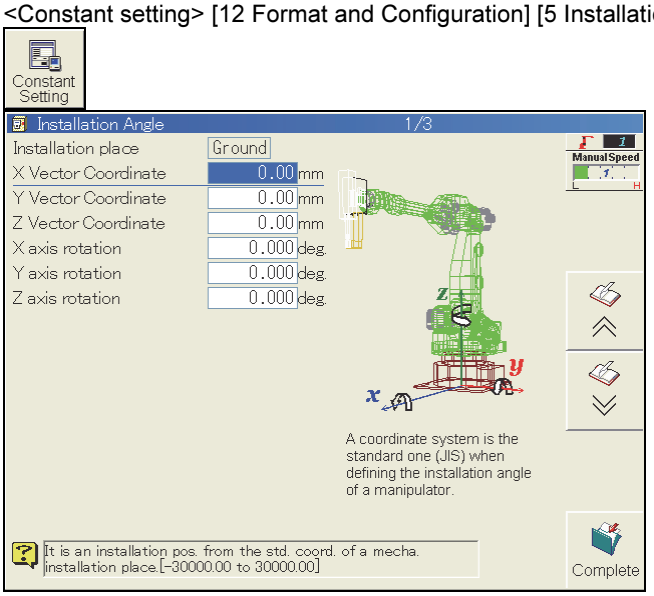
Available installation angle differs due to the robot type. Please refer to the corresponding specification sheet for the detail of it. Some robot permits floor installation only.

How to open the setting screen

After changing the operator class to ***EXPERT*** by inputting [R][3][1][4][Enter] [Enter], open the following menu.



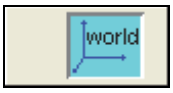
<Constant setting> [12 Format and Configuration] [5 Installation Angle]



After inputting the respective parameters, press <Complete> key to save the setting in the internal memory.

In case of floor installation

- If robot is only one and options such as synchronization control is not used, it is not necessary to change the setting of the installation angle.
- In this case, ***"Word coordinate system"*** and "***Machine coordinate system (=Robot coordinate system)***" is same.

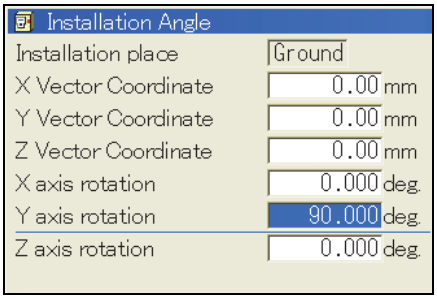


"Word coordinate system"

"***Machine coordinate system (=Robot coordinate system)***"

- In the setting screen of ***"Mechanism relation"*** in memory format menu, please select ***"Ground"*** as the installation location of the robot.

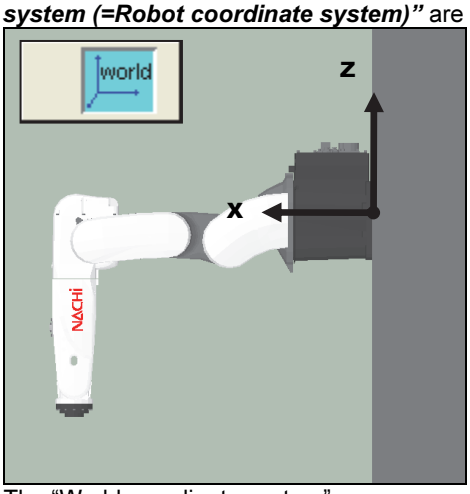
In case of wall installation (example)



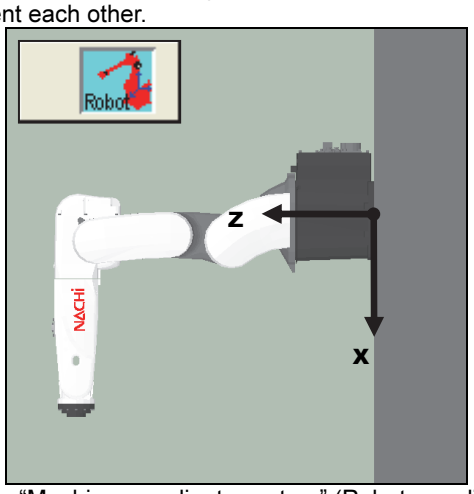
- Set ***"90"*** for the ***"Y axis rotation"***.

- In the setting screen of ***"Mechanism relation"*** in memory format menu, please select ***"Ground"*** as the installation location of the robot. (Do not select "Wall mount")

(NOTE) The direction of the manual operation
In this case, the movement direction of the ***"World coordinate system"*** and the ***"Machine coordinate system (=Robot coordinate system)"*** are different each other.



The "World coordinate system"



"Machine coordinate system" (Robot coordinate system)

※Robot on this picture is just an example for the explanation. It does not coincide with the actual robot.

CAUTION

Even if your robot is available to use in wall installation, its motion range may be restricted comparing to the floor installation. Please refer to the corresponding specification sheet for detail of it.
If robot is operated outside the permitted motion range, motor or reduction gear may be damages and robot is out of guarantee.

In case of tilted (slant) installation (example)

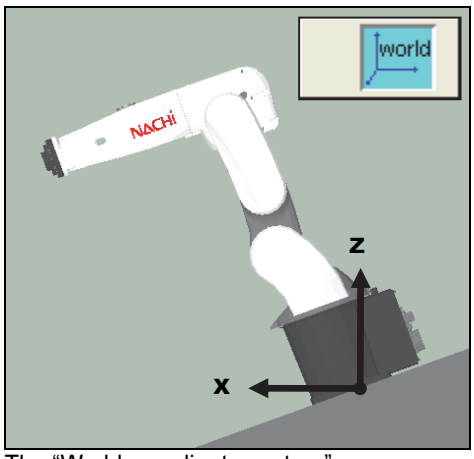
Installation Angle	
Installation place	Ground
X Vector Coordinate	0.00 mm
Y Vector Coordinate	0.00 mm
Z Vector Coordinate	0.00 mm
X axis rotation	0.000 deg.
Y axis rotation	20.000 deg.
Z axis rotation	0.000 deg.

- Set ***"20"*** for the ***"Y axis rotation"*** for this example.

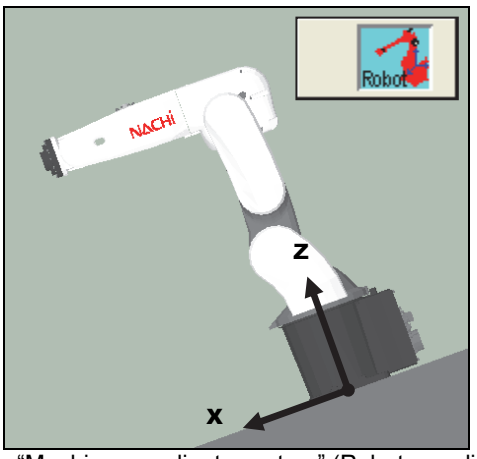
- In the setting screen of ***"Mechanism relation"*** in memory format menu, please select ***"Ground"*** as the installation location of the robot. (Do not select "Wall mount")

(NOTE) The direction of the manual operation

In this case, the movement direction of the ***"World coordinate system"*** and the ***"Machine coordinate system (=Robot coordinate system)"*** are different each other.



The "World coordinate system"



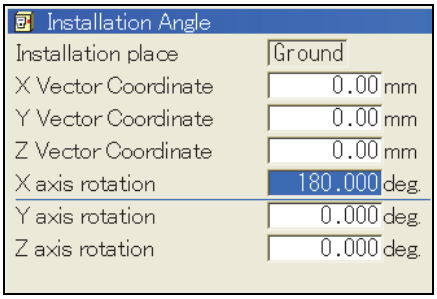
"Machine coordinate system" (Robot coordinate system)

※Robot on this picture is just an example for the explanation. It does not coincide with the actual robot.

CAUTION

Concerning the slant angle, please consult with our technical department in advance.
If angle is extremely big (Ex; bigger than 30 [deg]), floor installation type robot cannot be used and wall installation type robot may be necessary.

In case of inverted installation (example)

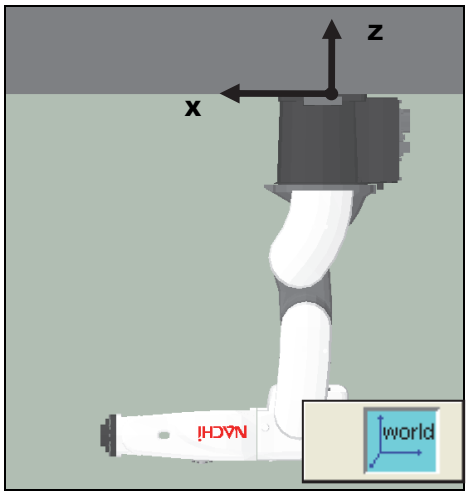


- Set ***"180"*** for the ***"X axis rotation"*** for example.

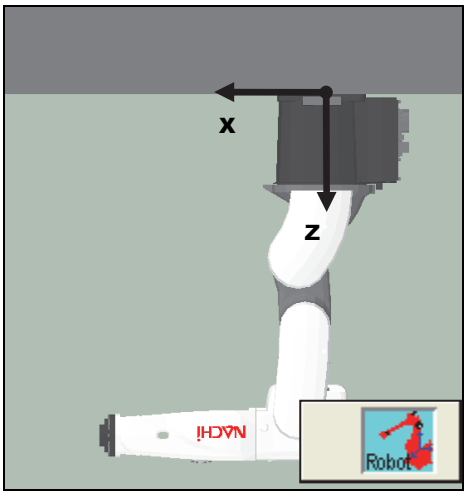
- In the setting screen of ***"Mechanism relation"*** in memory format menu, please select ***"Ground"*** as the installation location of the robot. (Do not select "Wall mount")

(NOTE) The direction of the manual operation

In this case, the movement direction of the ***"World coordinate system"*** and the ***"Machine coordinate system (=Robot coordinate system)"*** are different each other.



The "World coordinate system"



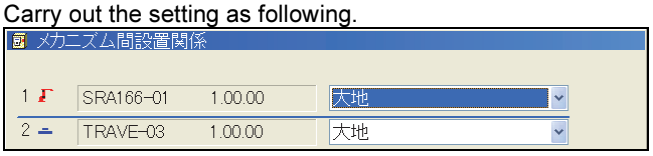
"Machine coordinate system" (Robot coordinate system)

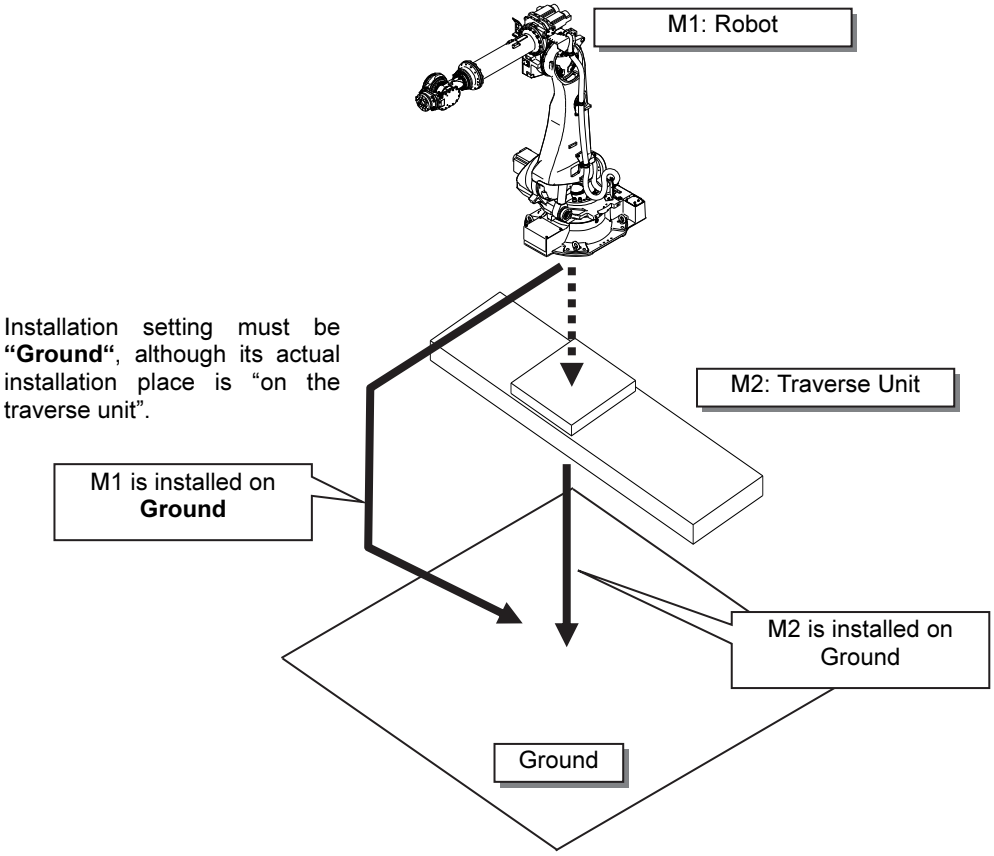
※Robot on this picture is just an example for the explanation. It does not coincide with the actual robot.

In case of traverse unit is added

Robot + Traverse unit 「**Synchronizing control is not used**」 and 「**RMU is not used**」

Carry out the setting as following.





INFO.

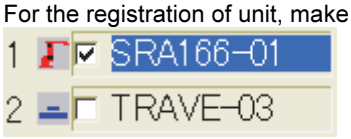
・This setting cannot be used for Synchronizing control.

・Also this setting cannot be used for the application in which RMU (Robot Monitoring Unit) is used, because correct TCP position on the world coordinate system cannot be calculated.

INFO.

In case of inverted installation, set ***"180"*** for the X axis rotation.

(Supplement)
For the registration of unit, make a check mark on only the robot in "Speed standard".



4.3 Installing a tool

In this section, a tool will be installed to the flange surface of the robot wrist. Depending on the intended application, the tool may be a spot welding gun, arc welding torch, material handling gripper or sealing nozzle gun.

4.3.1 Installing a tool (SRA166H-01)

When a tool is to be installed, it need not necessarily that a tool faces straight up or straight down. However, confirm that, by operating the 6th axis (tip axis), the tool reaches the proposed range.

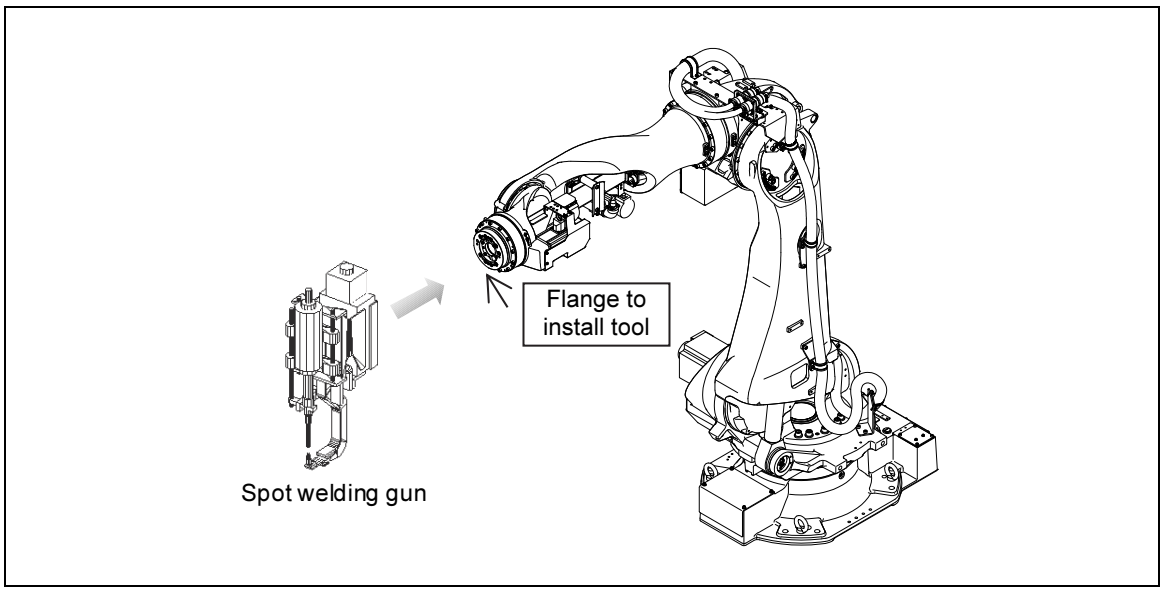


Fig. 4.3.1 Installing a tool (Spot welding gun)

For the layout of the installation bolt holes and other detailed specifications, refer to the figure below.
The installation area differs from one robot model to another. Details are provided in the instruction manual "MANIPULATOR" or Standard specification sheet of the model concerned, and so refer to them.

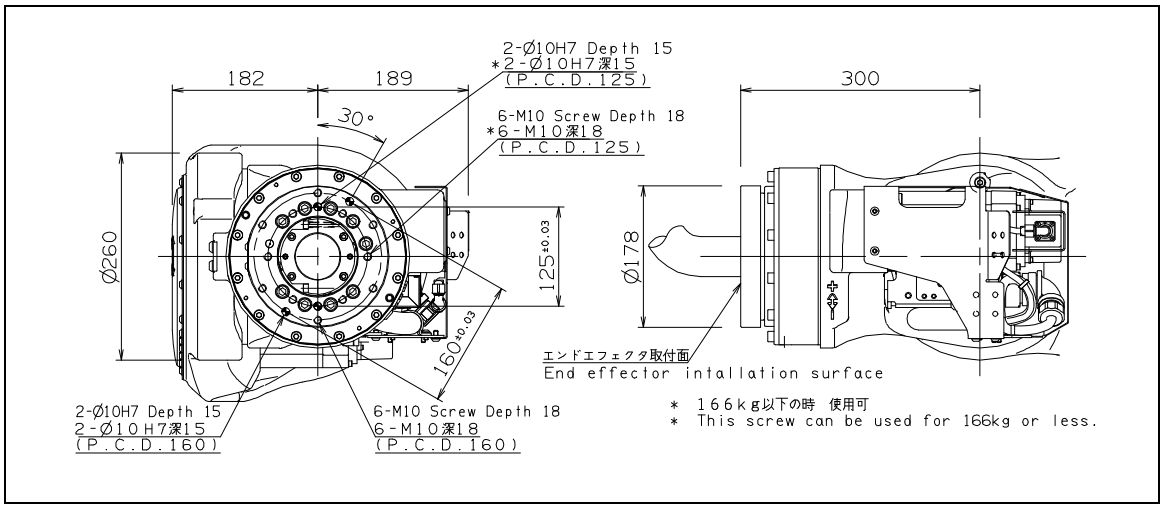


Fig. 4.3.2 Detailed outline drawings of tool installation area

CAUTION

・The depth to which the tool (end effecter) installation bolts are to be screwed in must be less than the depth of the threads in the tool installation surface. The wrist may be damaged if the bolts are screwed in beyond the depth of the threads.
・On the other hand, if the bolts were too short or tightening torque was not enough, tool may drop off while robot moving. Pay utmost attention.

4.3.2 Performing encoder reset and encoder correction

IMPORTANT

Encoder reset procedure is to initialize the position data in encoder and Encoder correction procedure is to determine the reference position of robot axes. Thus these procedures are very important.

After installing a tool on robot by customer, perform these procedures only when necessary, by referring to the following explanation.

When performing, these procedures must be done **before beginning the teaching operation**. If the encoder correction is performed after the teaching operation has been finished, the reference position of each axis may change, so the work programs may not be able to be played in correct position.

Also these procedures are necessary when motor, encoder or robot body is replaced. In such case, perform these procedures by referring to the following explanation.

Cases when encoder correction is necessary

- Robot that uses "Zeroing pin and block" (SRA and or so) ….. As for the heavy load robot, perform encoder correction for all axes after installing a tool. Always perform encoder correction with same conditions (load conditions and robot posture). So **"Reference pose"** in which the all axes are set to the reference position with zeroing pin etc. is recommended as the robot posture to perform this. And, if the tool is replaced to one that has different mass or different COG (Center of Gravity), please do not forget to perform the encoder correction for the all axes again. Because in a case like that, the load balance of the robot will change and the encoder correction values (offset values) for the all axes may change.

- Robot that uses "Origin adjusting match-mark" (NV6 and or so) ….. After installing a tool, perform encoder correction only when the reference pose check program (P9999) does not provide the position where all the origin adjusting match-marks are in alignment.

- When encoder reset is performed, encoder correction must be performed without fail.

Cases when encoder reset is necessary

- When motor, reduction gear, encoder or robot body has been replaced

- When connector to the encoder or connector to the encoder charging battery has been disconnected

- When the following errors have occurred:
  - E0030 Encoder absolute data failure
  - E0031 Motor rotation too fast when turning Motors ON
  - E0050 Encoder counter overflow/underflow
  - E0052 Encoder battery charge low
  - E0055 Motor rotation too fast when power off
  - E0057 Encoder count status failure
  - I1016 Manipulator battery warning
  - I4905 Playback was started in the state that the basic posture of any axes is not setup.

INFO.

- Concerning the detailed procedures of the encoder reset and the encoder correction for the additional axes, please refer to the respective instruction manuals. In case of a servo gun, refer to the instruction manual "SERVO GUN ADJUSTMENT PROCEDURE FOR EXPERTS".
- (This procedure is provided to several limited robots) To improve the position accuracy of the TCP (Tool Center Point), please modify the encoder correction values by referring to "**More accurate encoder correction**" of the instruction manual "MANIPULATOR" of each robot, after performing normal encoder correction.

IMPORTANT

Reference position (zeroing position) is the axis position where "Origin adjusting match-mark" matches or “Zeroing pin” can be inserted. When all axes are in reference position (zero position), it is called reference pose (zeroing pose). Please refer to the instruction manual "MANIPULATOR" for detail.

In case of inverted, wall and tilted installation robot

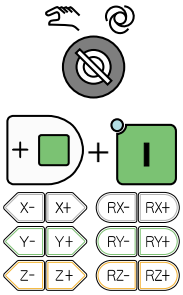
For all shipped robot, encoder correction is performed with robot that is installed on the floor. But, in case that robot is installed with another method (inverted, wall and tilted installation), correct reference position of each axis will change because stress direction on each axis is different from that of floor installation. Due to this difference, robot may not move correctly (positioning or locus accuracy becomes worse).

IMPORTANT

In order that robot can move correctly,
・WITH ALL THE LOADS ARE EQUIPPED on the wrist and the upper arm,
・Before starting the teaching procedure,
・For all axis whose stress direction is changed,
・At the reference pose (all axis in reference position by using zeroing pin or etc.)
perform encoder correction.
(In this time, encoder reset is unnecessary.)

If encoder correction is carelessly performed after teaching is done, it would make a big change on T.C.P. (Tool Center Point), then all the points which you taught are needed to be modified.

Moving to the Mechanical reference pose and selecting the menu items



1 Select the teach mode.

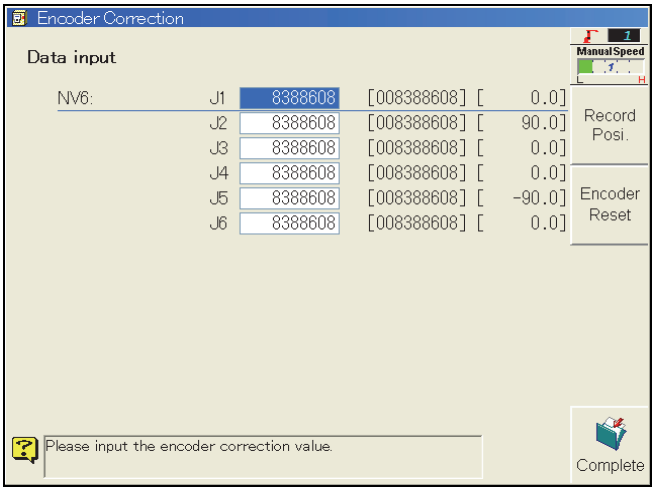
2 Turn on the servo power supply.

3 Perform manual operations in such a way that all the robot's axes are aligned with the reference positions.
(A robot posture in which the all axes are set to the reference positions is called "**Reference pose**")

The reference pose differs from each other. For details, refer to the instruction manual "MANIPULATOR" of each robot.

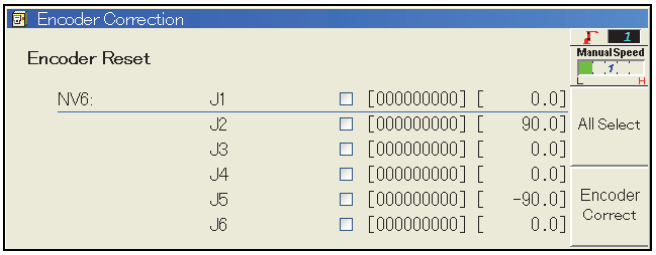
4 Open <Constant Setting> - [3 Machine Constants] - [4 Encoder Correction].

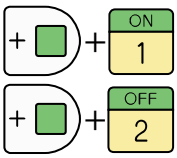
Now proceed with the encoder reset and encoder correction operations. (These are described on the next and subsequent pages.)
The screen that appears when the menu is selected is the screen on which the encoder correction is performed. The encoder correction or encoder reset operation is selected on this screen.



Encoder Reset procedure

1 To reset the encoder, press f9 <Encoder Reset>.
>>The encoder reset screen is selected.

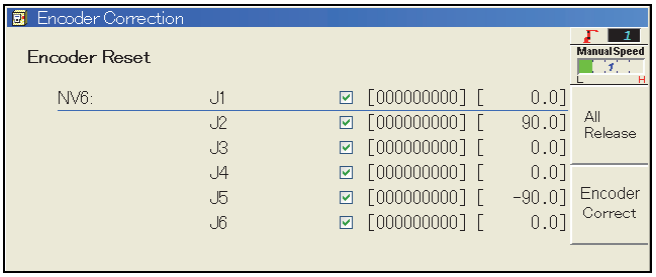




2 To reset a specific axis only for replacing a motor, for instance, select the axis, and press [ENABLE] + [1].
>>A check mark appears for the selected axis.

To release the selected axis, press [ENABLE] + [2].

3 To reset all the axes at once, press f8 <All Select>.
>> All the axes are selected, and check marks appear for them.
The selected status can be released by pressing f8 <All Release>.



4 When the axis to be reset is selected, press f12 <Execute>.
If the robot axes are not equipped with a brake, press f12 <Execute> while keeping the servo power on. (If all the axes of the robot are equipped with a brake, this operation may be performed with the servo power off.)

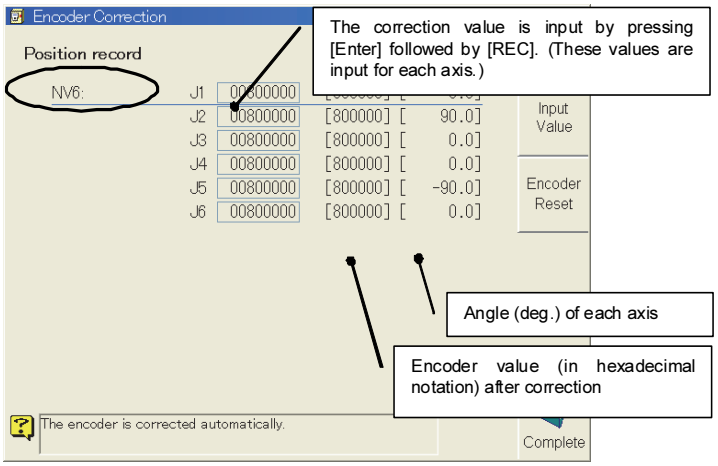
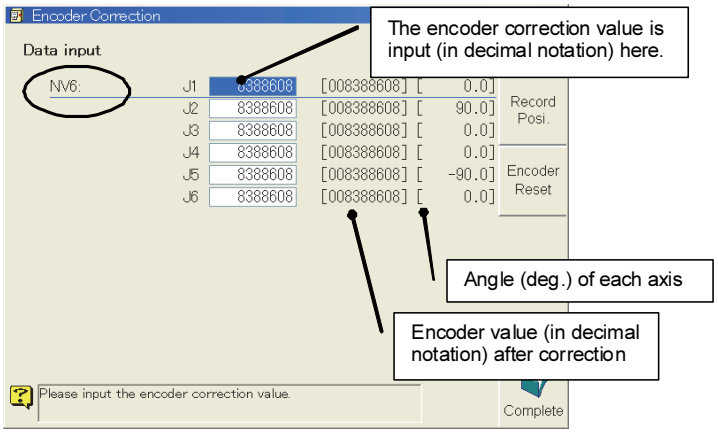
>>If the encoder reset is successfully finished, a message to show the result will appear.

Encoder Correction procedure

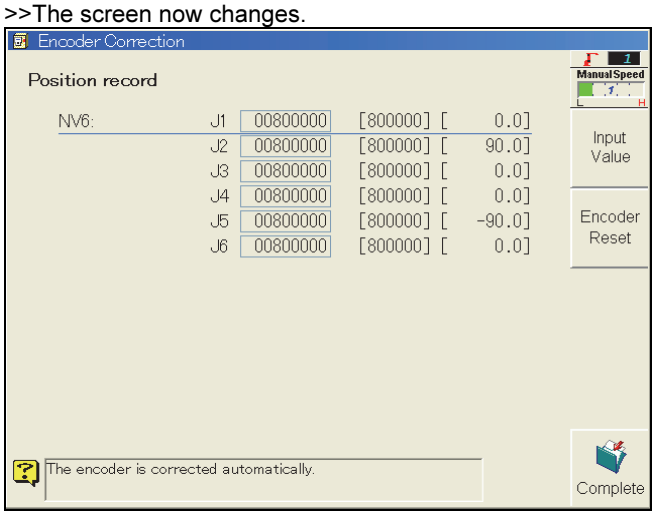
Encoder Correct

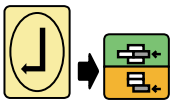
1 Upon completion of the encoder resetting, proceed with the encoder correction.
Press f9 <Encoder Correct>.
>> The screen which appeared immediately after [3 Machine Constants] [4 Encoder Correction] were selected is restored.

2 Either "Data Input" or "Position Record" can be used as the method for encoder correction.

Correction method	Details
Position Record	In this screen, the mechanical position is regarded as a reference position for the axis when [Enter] and [REC] keys are pressed and then the encoder correction value is calculated and set. Select this method at a production process or when a motor or mechanism is to be replaced. Be absolutely sure to perform the operations with the robot placed in a posture where the all axes are aligned to the "reference position". 
Data Input	Use this method when the encoder correction values are already known. An "encoder correction value which is already known" is a post-mastering encoder correction value which is provided inside the controller when the robot is shipped from the factory. Therefore, cases where this screen is used to set the values after shipment are as follows; • When the encoder battery has been replaced • After the controller's memory has been formatted When these values are input, it is acceptable for the robot to be in any position and any posture. 

3 The "Position Record" method is described here.
Press f8 <Record Position>.
>>The screen now changes.





4 After confirming that the axis is mechanically aligned to the reference position, align the cursor with the axis whose encoder is to be corrected, and press [Enter] followed by [REC].
If the robot axes are not equipped with a brake, press [Enter] and [REC] while keeping the servo power ON ([ENABLE SWITCH]). (If all the axes of the robot are equipped with a brake, this operation may be performed with the servo power OFF.)
* Encoder correction cannot be implemented for all the axes together so repeat these operations for each axis in turn.

5 At this stage, the encoder correction values are still not saved in the memory.
To save them, first turn the motor power OFF (by pressing [EMERGENCY STOP BUTTON]).
Then press f12 <Complete>.

If "Reference position check program". is not recorded in memory, it is recommended to record this "Reference pose" (a pose in which the all axes are aligned to the reference positions) to program 9999 as a "Reference position check program". This program is convenient to check if the all axes of the robot are correctly set to the reference position respectively.

This work includes some jobs that should be conducted with the motors ON. Consequently, be sure to conduct the work at least by a pair of two persons. One person must stay on guard to press an Emergency Stop button at any time, while the other person must promptly finish the work with thorough attention paid to the robot operating area. Furthermore, prior to starting the work, check for escape route. If this procedure is omitted, operator may be caught or pinched by the robot parts, possibly resulting in death or serious injury.

As for the robot using “Zeroing pin and block”, check to be sure that the zeroing pin has been removed and then operate the robot. Note that operating the robot with the zeroing pin inserted may bend the pin or deform the hole for this pin, thus disabling proper positioning of the zeroing pin.

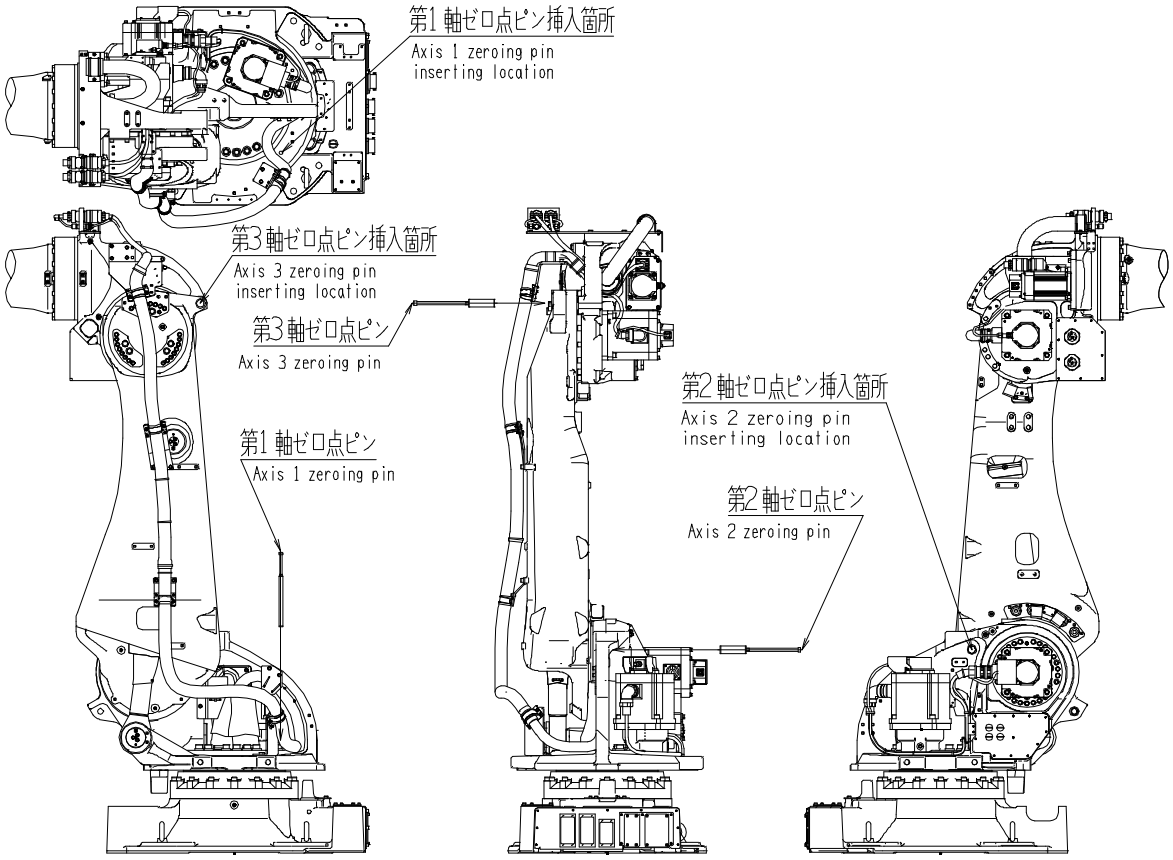
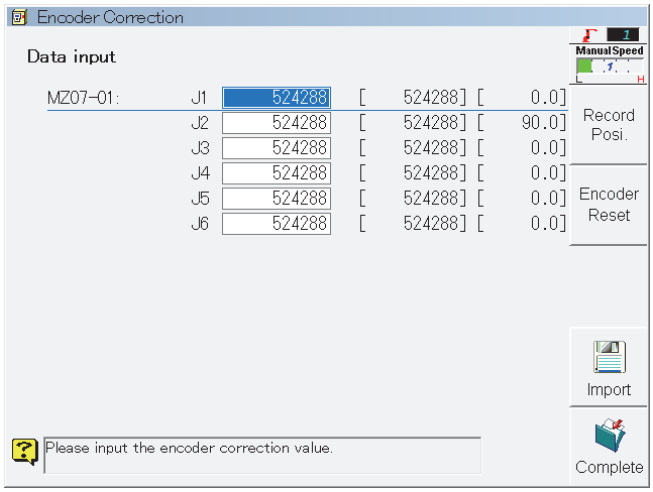


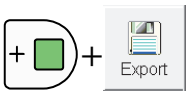
Fig. 4.3.3 A Pose to insert the zeroing pin (J1,J2 and J3 axis of SRA166H-01)

Export Encoder Correction data to file

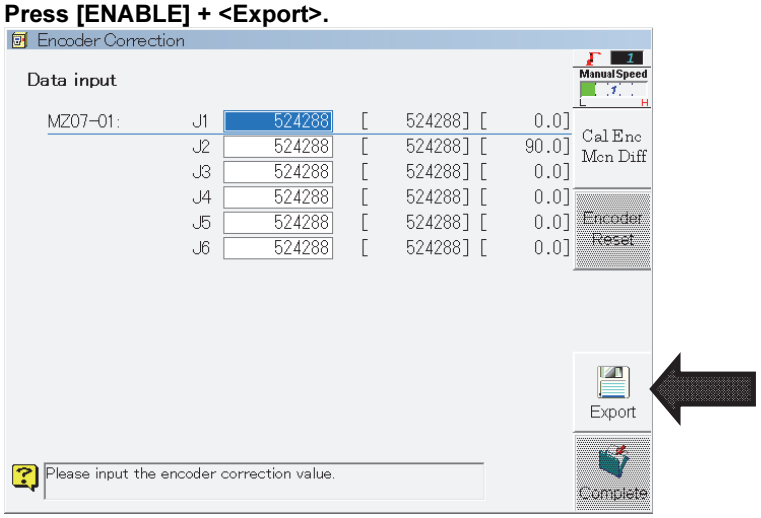
Encoder correction values stored in controller can be exported to file.
For this operation, operator class of ***SPECIALIST*** is necessary.

1 **Open <Constant Setting> - [3 Machine Constants] - [4 Encoder Correction].**

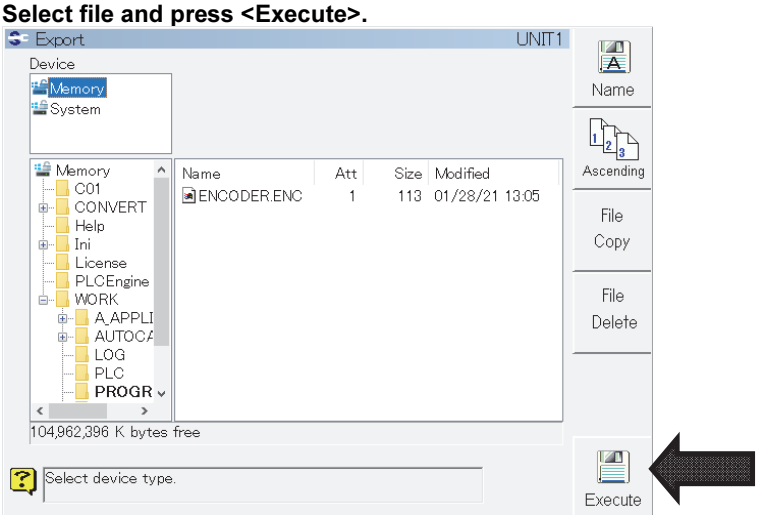


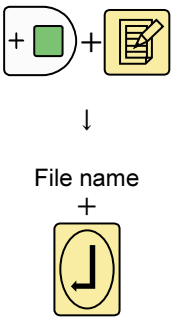


2 **Press [ENABLE] + <Export>.**

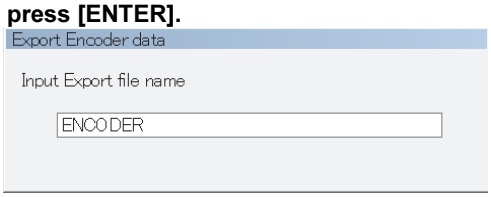


3 **Select file and press <Execute>.**





4 **Press [ENABLE] + [EDIT] to open software keyboard and key in the file name. Then press [ENTER].**



※ This sample shows the case of "ENCODER.ENC"

※ Please refer to the instruction manual BASIC OPERATION for detail of software keyboard.

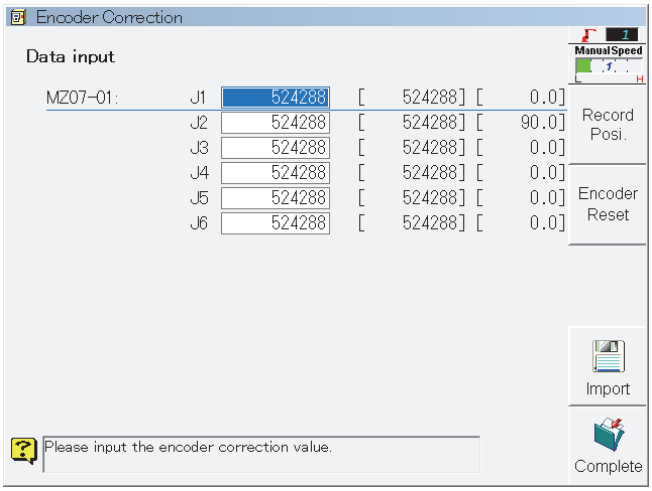
5 **New file of following contents has been created.**

```
[ENCODER]
TIME=2018/09/24 10:07:2
MEC1_NAME=MZ07-01:
MEC1_OFF=524288, 524288, 524288, 524288, 524288, 524288
```

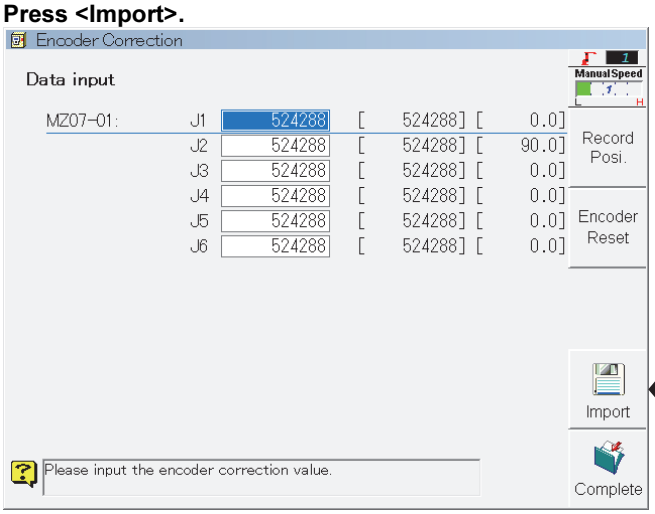
Import Encoder Correction data from file

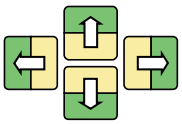
Encoder correction values can be read from the file created by the above instruction.

1 **Open <Constant Setting> - [3 Machine Constants] - [4 Encoder Correction].**

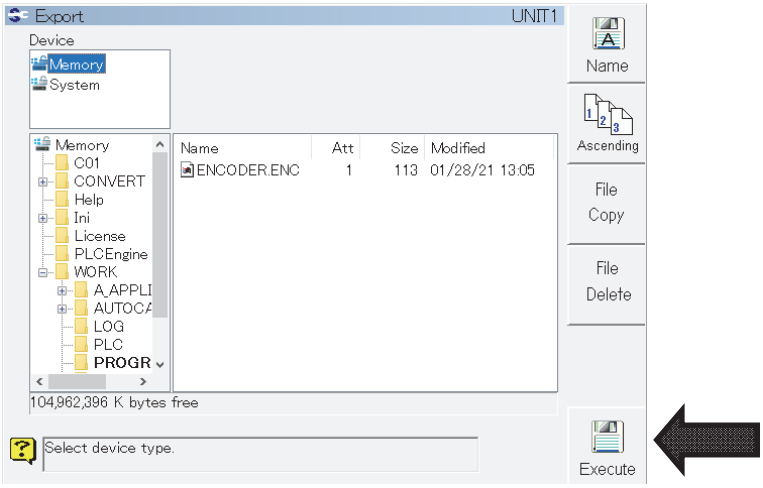


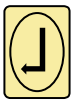
2 **Press <Import>.**



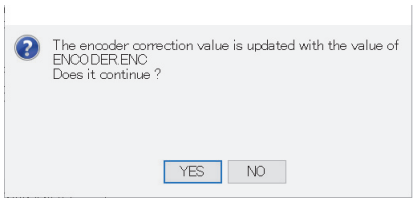


3 **Select file and press <Execute>.**

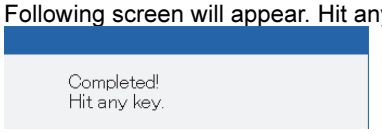




4 **Following screen will appeare. Select [YES] and press [ENTER].**
Encoder correction value is read from the file and renewed.



Following screen will appear. Hit any key.



5 **Press <Complete> to store the file in the memory.**

4.4 User load (service load) setting

If additional loads except for the end effecter (tool) are installed on the robot, please set the parameters of the loads (C of G, mass and moment of inertia) based on the coordinate system like the picture shown as the follows in advance.

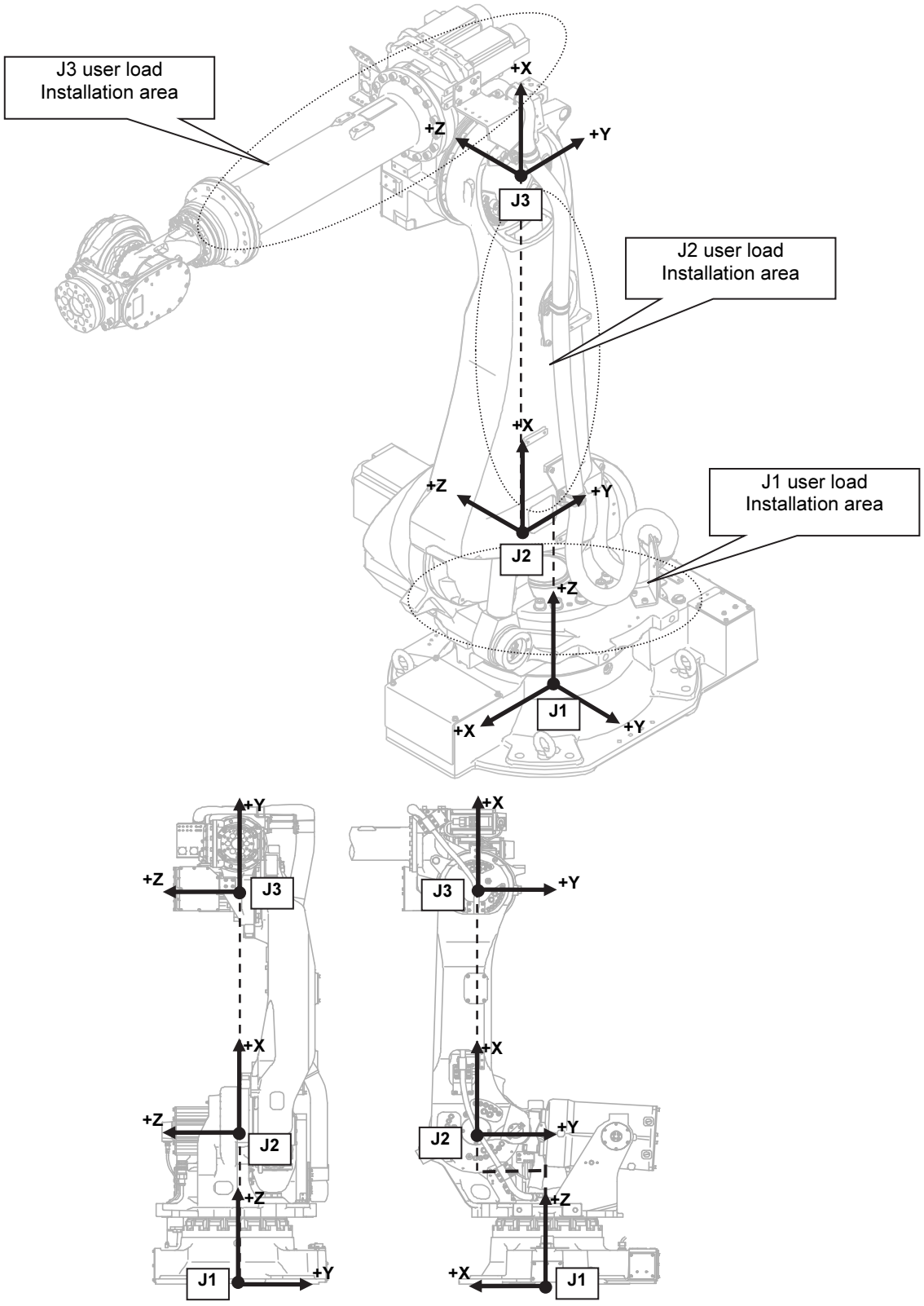


Fig. 4.4.1 Reference coordinate systems of the user load (An example of SRA166-01)

Open <Constant Setting> - [3 Machine Constants] - [2 Service load].
Input the respective parameters and press f12<Complete> to save those parameters.

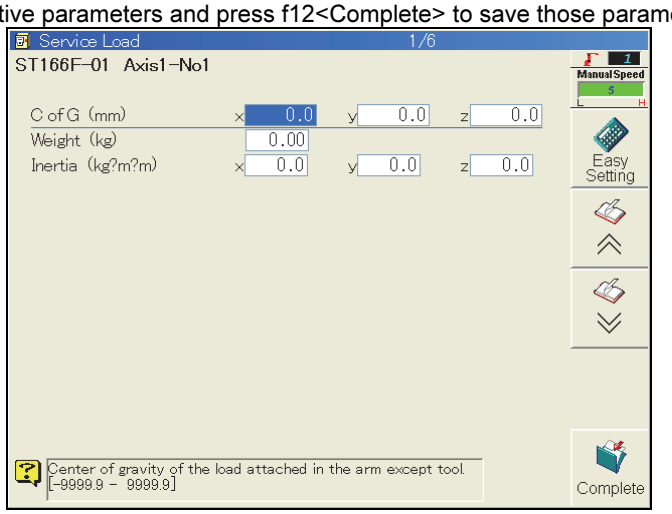


Table 4.4.1 Service load (It is possible to set up to 2 service loads for J1,J2 and J3 axis respectively)

Parameter name	Setting value
C of G (mm)	Set the coordinates (x,y,z) of the COG (center of gravity) of the load based on each coordinate system (unit is mm)
Weight (kg)	Set the weight of the service load (unit is kg)
Moment of Inertia (kgm2)	Set the moment of the inertia.(unit is kgm2) After setting the C of G and the Weight , it is possible to set the inertia of the service load easily by inputting the approximate shape (a,b,c) in mm (To use this function, press f key <Easy Setting>)

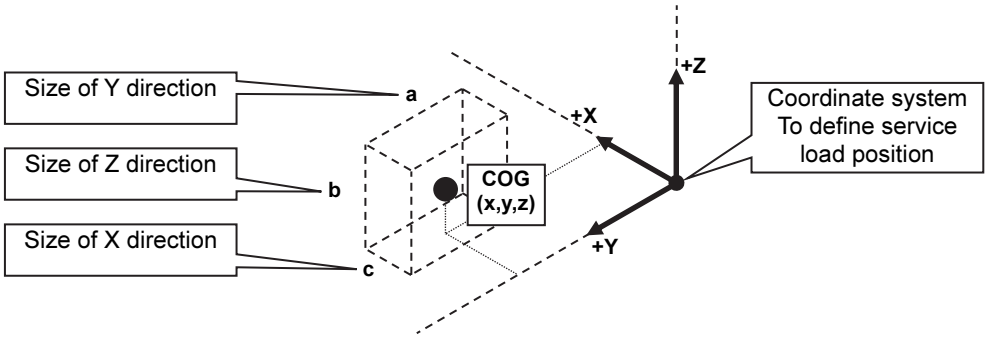


Fig. 4.4.2 COG position and size of service load

CAUTION

Same as the COG and weight setting of tool, service load setting is also important to improve the acceleration/deceleration control.
Wrong setting may cause the fatal damage on machine. In this case robot is out of guarantee.

CAUTION

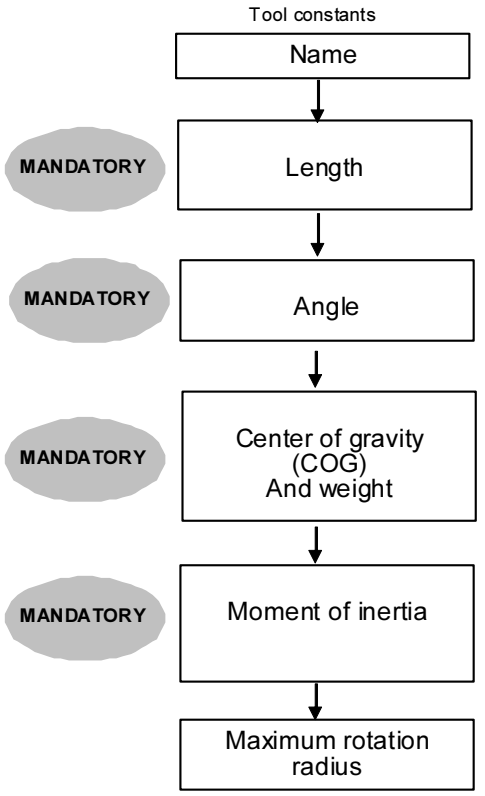
Excessive service load over the specification of robot cannot be attached.

4.5 Tool constant settings

The “tool constants” refer to a set of parameters including the length, angle, center of gravity, weight and moment of inertia of the installed tool. These parameters are extremely important for ensuring precise linear operations and appropriate acceleration/deceleration control. Before moving the robot, read carefully through the instructions in this section and take the steps described without fail. Tool constants for up to 32 tools can be stored in this controller’s memory. If an application involves the use of a multiple number of tools, perform the settings for all the tools concerned.

Continued use under the wrong settings for the center of gravity, weight and tool’s moment of inertia may fatally damage the machine. Perform the settings set forth in this section without fail.
The settings must be performed even for small and/or lightweight tools. The same settings used for a large tool cannot be used for a small tool.

Table 4.5.1 Tool constants



A name can be set for each of the tools. A tool name may consist of not more than 16 alphanumerics and symbols. (Japanese characters cannot be used.)

This constant is the TCP position defined on wrist coordinate system using X, Y and Z axis length components. It is absolutely necessary in order to ensure precise linear movements.
When the **tool length automatic setting function** is used, the tool length can be ascertained automatically using the already created program.

This constant is the TCP angle defined on wrist coordinate system using X, Y and Z axis rotation components. It proves useful since, when teaching, the tool can be operated manually in the direction in which it is pointing. When the **tool angle simple setting function** is used, the tool angle can be set easily.

This constant is the tool's COG (center of gravity) position defined on wrist coordinate system and its weight. It is required in order to ensure appropriate acceleration/deceleration control.
The constant is set using the **tool center of gravity (COG) and weight automatic setting function**. (The weight of a tool cannot be input manually.)

This constant is the tool's moment of inertia defined on the coordinate system whose origin is the COG of tool (not same as wrist coordinate system). It must be set if the moment of inertia has exceeded the allowable value.
When the **tool moment of inertia simple setting function** is used, the moment of inertia can be set easily by designating the tool shape.

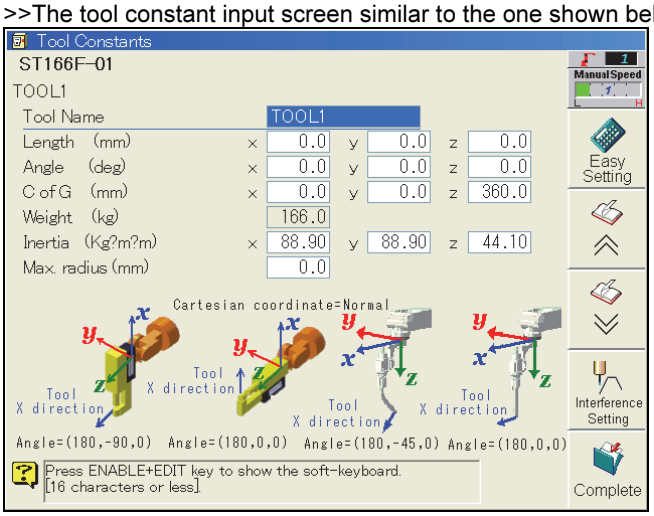
This constant is the max. radius of the tool. It is used to check the territory, etc.

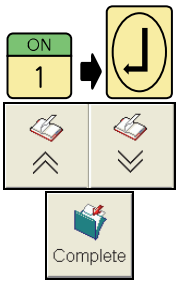
Common operating procedure for setting tool constants

(With the exception of the tool weight, all of the tool constants are set on the same screen shown below.)

1 **Select the teach mode.**

2 **Select <Constant Setting>- [3 Machine constants] - [1 Tool constants].**
>>The tool constant input screen similar to the one shown below now appears.





3 **Align the cursor with the desired position, input a number (such as 1), and then press the [Enter] key.**

4 **To change the tool number, press the page up or down key.**

5 **Upon completion of the settings, press the <Complete> key. The settings are now saved in the constant file.**
>>Operation returns to the machine constant menu screen.

4.5.1 Tool name

With an application which involves the use of a multiple number of tools, the parameters become more comprehensible if the welding gun or torch name and model, for instance, are registered here first.
It is not required to set the tool name. The initial setting may be used as is. (Initial setting: TOOL* where "*" is the tool number)
The tool name does not appear on the programs display screen.

A tool name may consist of not more than 16 alphanumeric and symbols.
Refer to the instruction manual "BASIC OPERATIONS MANUAL"

4.5.2 Tool length

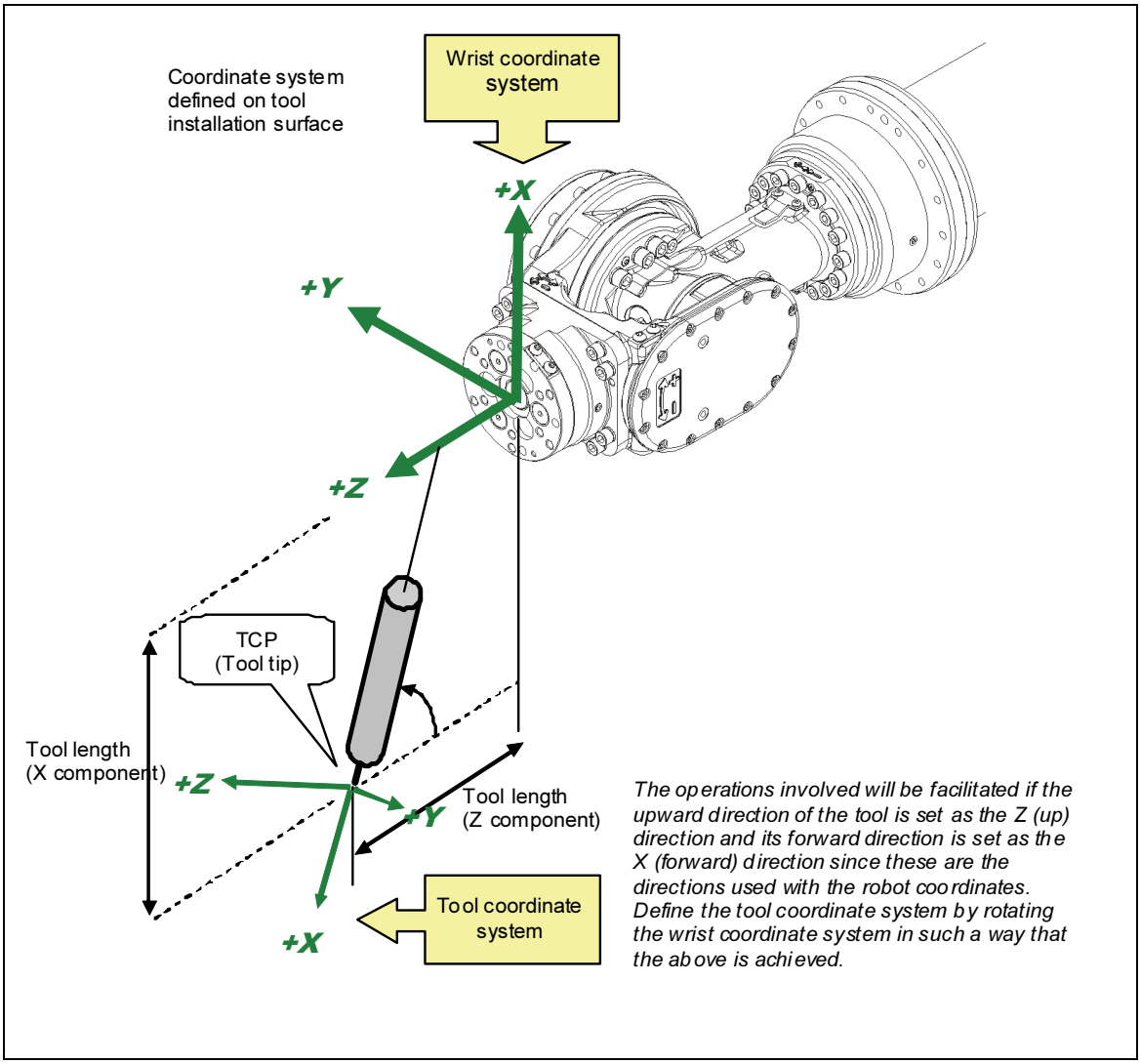


Fig. 4.5.1 Illustration of tool length and angle

The tool length is the coordinates of the X, Y and Z component of the tool tip in the wrist coordinate system. Similarly, the tool angle expresses the inclination of the tool tip in the wrist coordinate system as the angle of rotation around the X, Y and Z axes. The coordinate system defined by these parameters is called the tool coordinate.

In the wrist coordinate system, the center of the tool installation surface serves as the zero point, and the direction in which this surface is pointing serves as the Z direction as is shown above.

Measure the tool length which was measured in accordance with the definition given above, and input it.

However, if the tool dimensions are not known or high-accuracy interpolation operations are required by a material handling application, for instance, use instead the method which automatically measures the tool length.

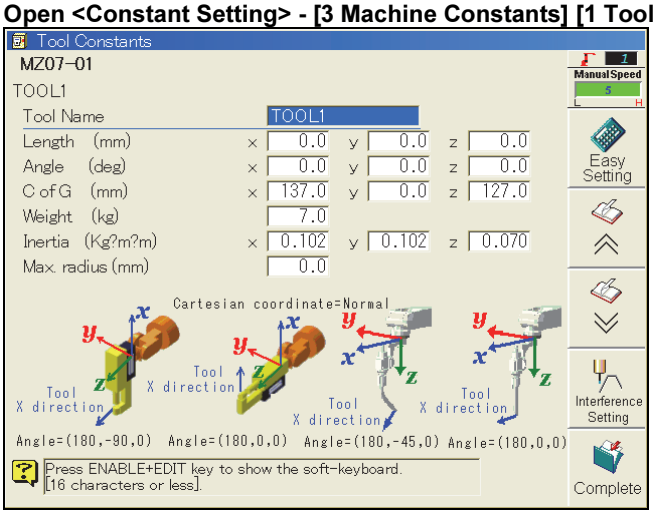
For the **tool length automatic setting function** described next to be used, the basic teaching and playback check jobs must be performed. Since these jobs cannot be done if the "BASIC OPERATIONS MANUAL" has not yet been read, do not set the tool length but use the initial setting as is and continue until the end of the setup is reached.
After reading the Basic Operations Manual, proceed with this setting again.

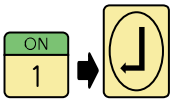
Setting the tool length manually (numerical value input)

If the tool tip coordinates based on the wrist coordinate system is known, please input the values following this procedure.

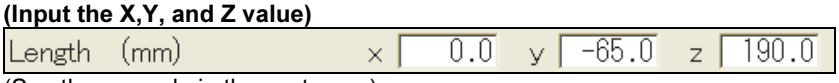
1 **Select the teach mode.**

2 **Open <Constant Setting> - [3 Machine Constants] [1 Tool Constants].**





3 **Input the tool tip position based on the wrist coordinate system.**
(Input the X,Y, and Z value)



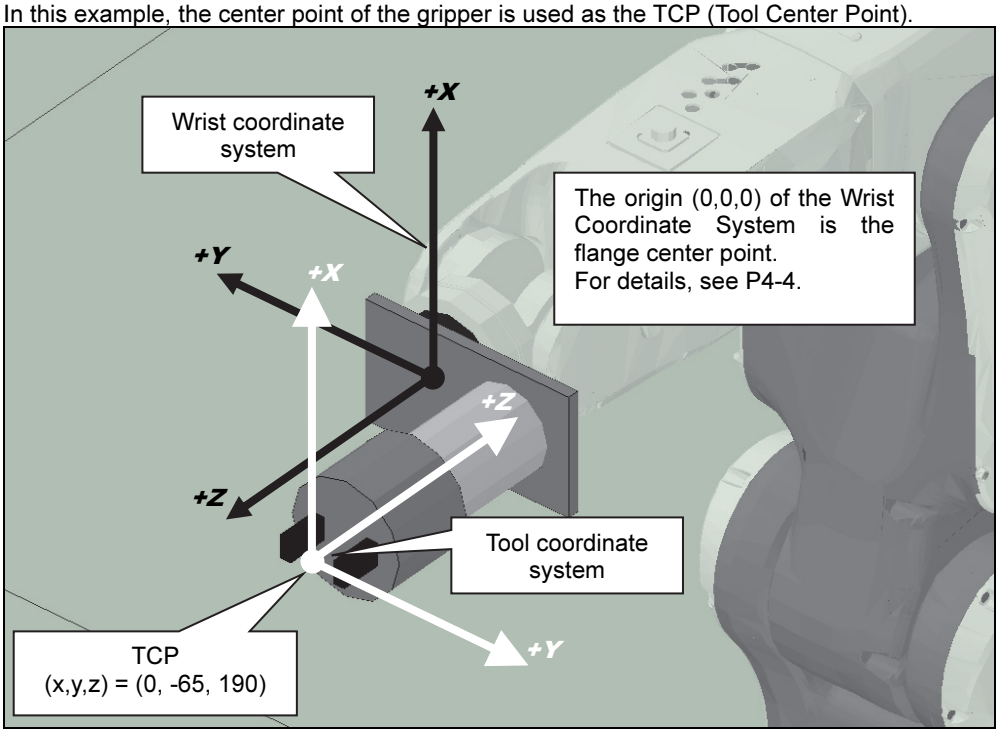
(See the example in the next page)

4 **Upon completion of the settings, press the <Complete> key. The settings are now saved in the constant file.**
>>Operation returns to the machine constant menu screen.

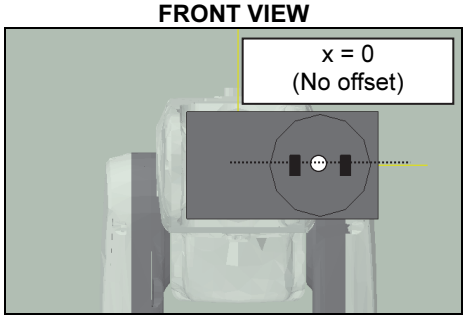
(NOTE) The “Complete” operation (=writing operation to the internal memory) cannot be executed if the Motor Power Source Circuit is ON. Turn the Motor power source circuit OFF by pressing the [EMERGENCY STOP BUTTON] before pressing the <Complete> key.

Tool length setting example (1)

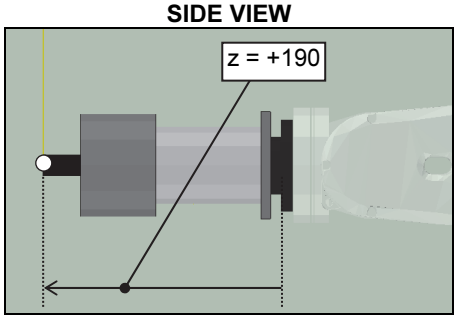
In this example, the center point of the gripper is used as the TCP (Tool Center Point).



FRONT VIEW



SIDE VIEW

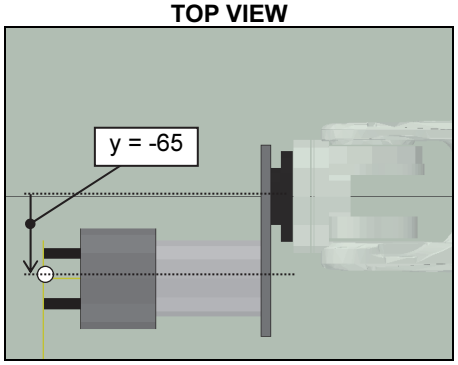


Based on the “Wrist coordinate system”, the TCP position (=Tool length) is;
(x, y, z) = (0, -65, 190)

And, if the “Wrist coordinate system” is rotated like the following, the desired direction of the tool coordinate system is acquired. (The order is z,y,x)
Around x axis : 180 [deg]
Around y, z axis : No rotation (0[deg])

Length (mm)	x	0.0	y	-65.0	z	190.0
Angle (deg)	x	180.0	y	0.0	z	0.0

TOP VIEW

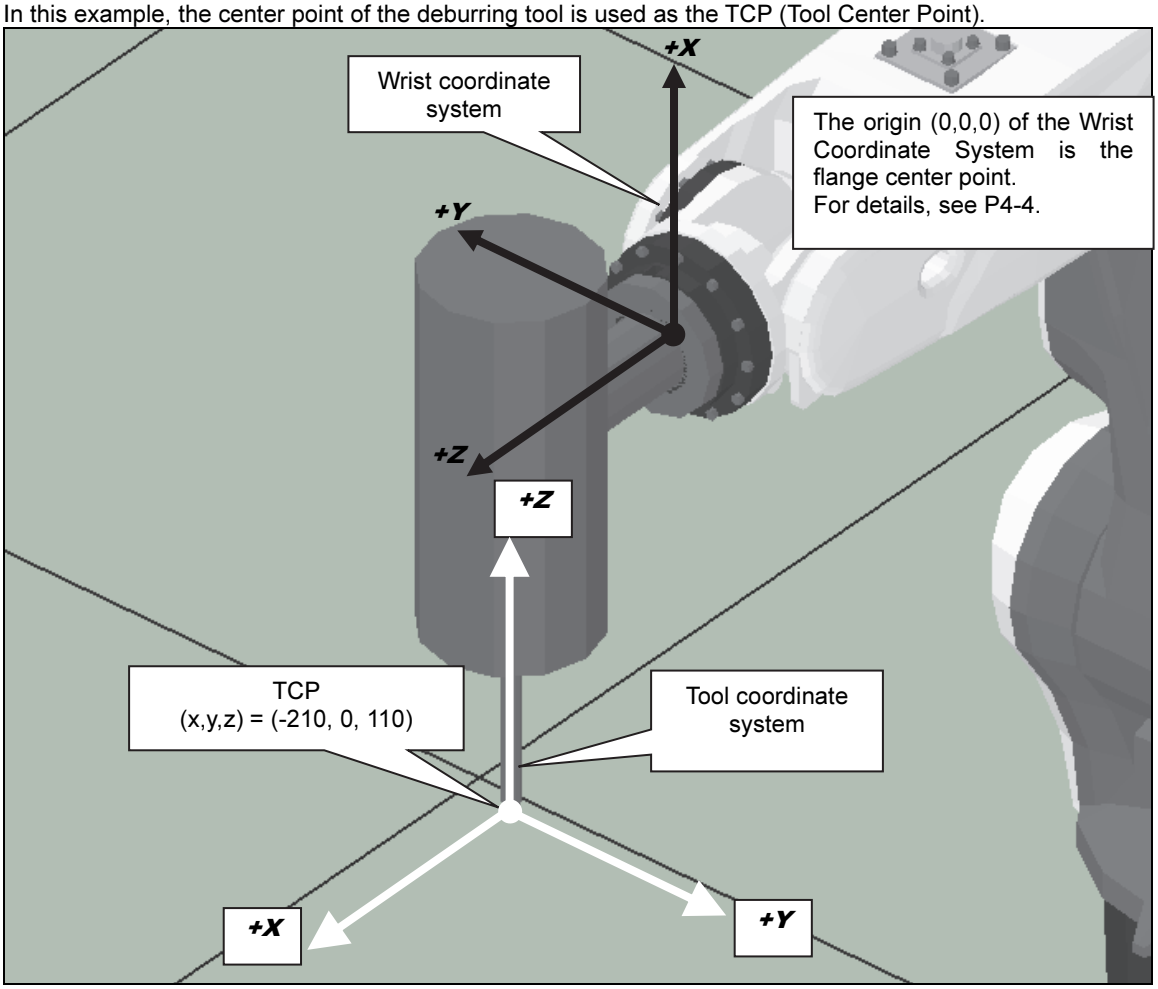


Normally, accurate motion path of the TCP is not required for most of the handling application. (Only the accurate position repeatability is required) So the setting accuracy of the TCP coordinates does not matter. However, if the application requires accurate motion path, please set the TCP position accurately referring to “Setting the tool length automatically”.

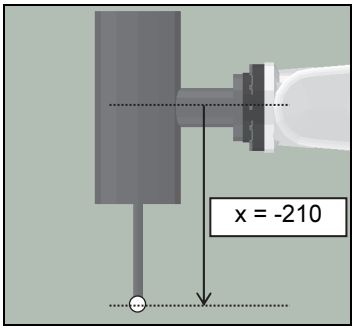
※Robot on this picture is just an example for the explanation. It does not coincide with the actual robot.

Tool length setting example (2)

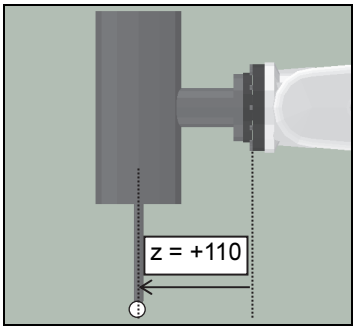
In this example, the center point of the deburring tool is used as the TCP (Tool Center Point).



SIDE VIEW



SIDE VIEW

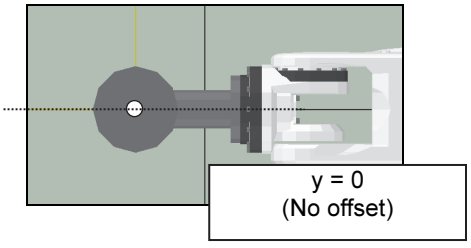


Based on the “Wrist coordinate system”, the TCP position (=Tool length) is;
(x, y, z) = (-210, 0, 110)

And, if the “Wrist coordinate system” is rotated like the following, the desired direction of the tool coordinate system is acquired. (The order is z,y,x)
X axis : 180[deg]
Y axis : -90[deg]
Z axis : No rotation (0[deg])

Length	(mm)	x	-210.0	y	0.0	z	110.0
Angle	(deg)	x	180.0	y	-90.0	z	0.0

TOP VIEW

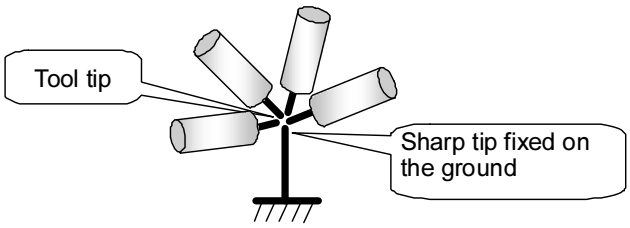


※Robot on this picture is just an example for the explanation. It does not coincide with the actual robot.

Setting the toll length automatically

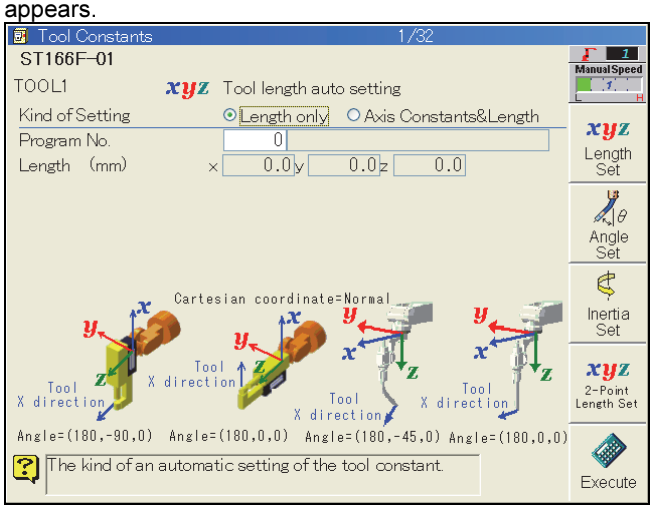
Tool length can be set automatically simply by taking this preparatory step. (Although one program for calculating the tool length must be taught.)
It does not matter whether the tool angle has already been set or not.

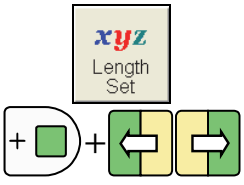
1 **First, the programs for setting the tool length automatically must be taught. Teach the kind of programs where the tip of the installed tool (install a tool with a sharp tip here as well) is aimed in a number of different postures at a sharp tip which has been secured to the ground. The required number of steps is at least 10.**



Ensure that the posture of the robot varies significantly with each of the steps, and that its aim is as accurate as possible. This holds the key for ensuring a high accuracy.
Record all the steps with linear interpolation ON. (Although it has nothing to do with calculating the tool length, this comes in handy in when checking the results in **7**.)

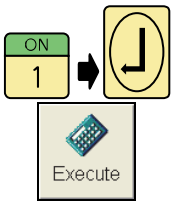
2 **On the tool constant setting screen for the desired tool number, press the <Easy Setting> key.**
>>The tool length automatic setting screen such as the one shown below now appears.





3 **If any other screen has appeared, press the <Length Set> key.**

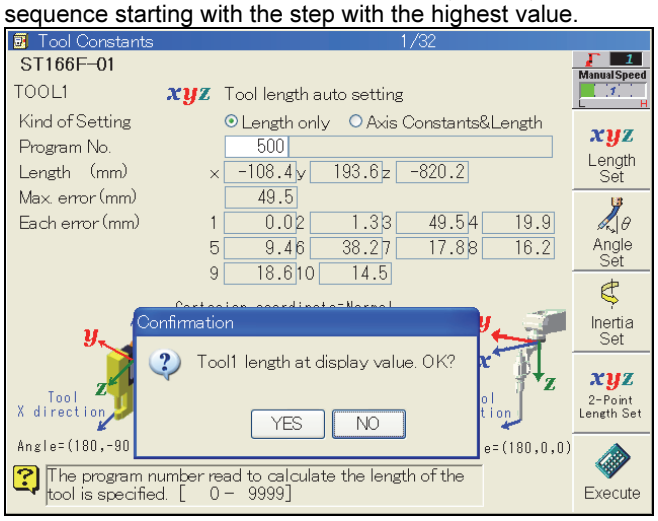
4 **Select the setting type. Select "Axis Constants & Length" or "Length only" using the [ENABLE] and [Left/right cursor] keys.**
Normally, "Length only" is selected.
Select "Axis Constants & Length" only when more accurate length setting is required.
In this case, the axis constants of J2, J3, J4 and J5 axes are corrected automatically.
(The axis constants of all the other axes remain unaffected.)
(The axis to be compensated differs depending on the mechanism type.)



5 **Align the cursor with the program No., input the program No. (such as 1) that was created previously in 1, and press the [Enter] key.**

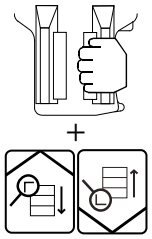
6 **Press the <Execute> key.**

7 **The tool length is calculated, and the results appear as follows a few moments later.**
>>The maximum error expresses the accuracy of the tool length which has been calculated. The lower the value here, the higher the resulting accuracy of the tool length which has been calculated.
The errors at each step up to a maximum of 10 steps are displayed simultaneously.
If the results in 9 below are not satisfactory, simply proceed to modify the position in sequence starting with the step with the highest value.

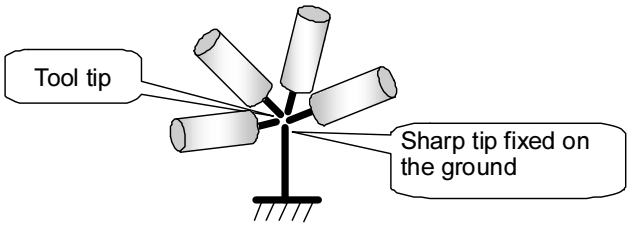


When the results are satisfactory, select [Yes] on the pop-up window, and press [Enter] key.
>>At this stage, only the display is updated, but the data is not yet stored in the constant file.

8 **Upon completion of the settings, press the <Complete> key. The settings are now saved in the constant file.**
>>Operation returns to the machine constant menu screen.



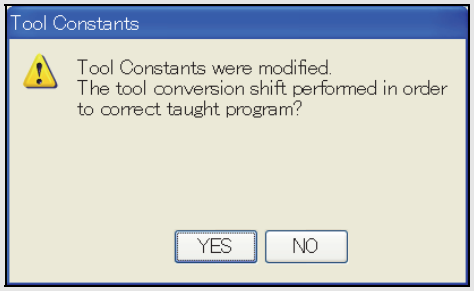
9 **Upon completion of the settings, check them.**
Exit the constant menu and try check go/back of program taught in 1.



If the tool tip hardly moves at all from the sharp tip secured to the ground even during operations between the steps, then the tool length has been set successfully. (It is not like the movements which resulted when the program was first taught.)

CAUTION

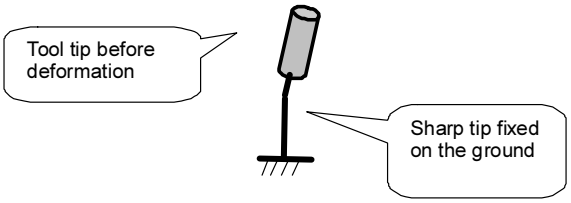
When pressing <Complete> key, following message will appear. If programs are already taught and these are not to be modified, please select [NO].



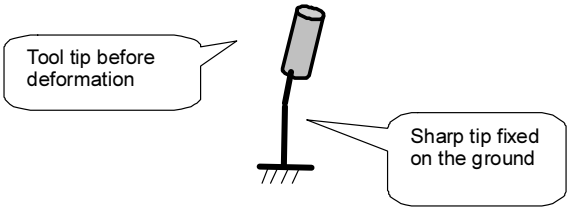
Tool Length Automatic Setting (2-point tool length setting)

In order to easily set a new tool length when the shape of a tool is deformed, **2-point tool length setting function** is prepared. In the case where the torch interferes during operation, or the torch is changed with a new one, be sure to use this function. By use of this function, the tool length after deformation is automatically calculated. It is necessary to teach the task program before and after tool deformation as a calculation program in advance.

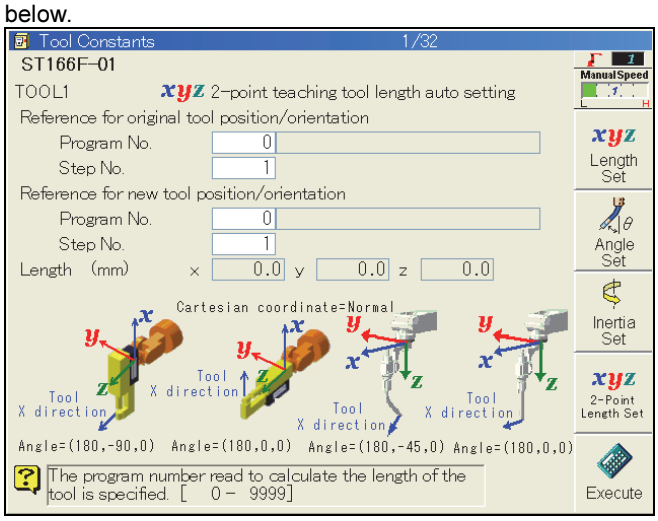
1 **First, it is necessary to teach the task program with the tool before deformation. Toward the sharp end fixed to the ground, carry out teaching (1 step) the task program which the attached tool tip (to which a sharp end is attached as well) is likely to target.**



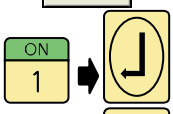
2 **Next, it is necessary to teach the task program with the tool after deformation. Carry out teaching (1 step) the task program in the same manner as in the above 1.**
>>Set the tool posture same as that taught in the above 1.



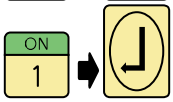
3 **In the tool constant setting screen of the desired tool number, press the <Easy setting> key.**
>>The 2-point teaching tool length automatic setting screen is displayed as shown below.



4 **If a different screen is displayed, press the <2-Point Length Set> key.**



5 **Move the cursor on the program of the reference point before conversion, and input the program number prepared in the above 1 (for example, No.1), and press [Enter] key.**

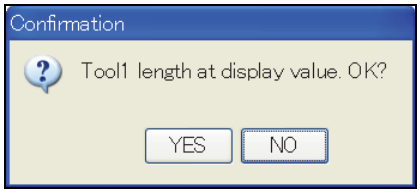


6 **Move the cursor on the step of the reference point before conversion, and input the step number prepared in the above 1 (for example, No.1), and press [Enter] key.**

7 **Input the program of the reference point after conversion, the program number prepared in step 2, and the step number in the same manner as in the above 5 and 6.**

8 **Press <Execute> key.**

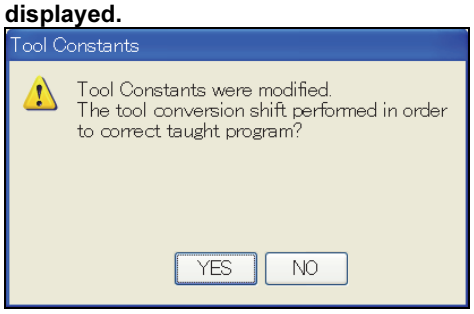
9 **The tool length is calculated, and after a while, the result is displayed as shown below.**



If it is all right, select [OK] on the popup window, and press [Enter] key.
>> At that time, only the display is updated, and the tool length is not stored in the constant file yet.

10 **After the setting, press <Complete> key. The set contents are stored into the constant file.**
>> The screen goes back to the machine constant menu screen.

11 **When the tool constants are changed, following pop-up window will be displayed.**



When the taught position for the robot in the taught program should be shifted according to the modified tool constants, select [YES] and press [Enter] key.
>>It goes back to the tool shifting operation.
Page 4-48 “4.5.7 Tool conversion”

When the program should not be shifted, select “NO” and press “Enter” key.
>> The screen goes back to the machine constant menu screen.

Additional information about tool length setting accuracy
The accuracy of tool length setting is affected by the following element, etc. It is strongly recommended that you check the tool length setting before starting the teaching as it may affect accuracy of XYZRPY-based movement command (robot coordinate system, user coordinate system, etc.) and shift command if tool length setting accuracy is low.

Encoder correction value in each axis
The tool length calculation is not accurate unless the reference position (encoder correction value) of each axis is not correct. In such case, **carry out the encoder correction procedure with the actual tool mounted** (by referring to the instruction manual MANIPULATOR). This may improve the accuracy of the tool length. However, please note that if you have already created programs, encoder correction's rework may change their teach points position, and all programs may require confirmation or position fixes.

Rigidity of the tool
If the tool rigidity is low and deflects significantly due to robot's posture, the accuracy of the tool length setting may become unstable. If your application requires position accuracy, consider rigidity when designing your tools.

4.5.3 Tool angle

Tool angle is defined as the inclination of tool on wrist coordinate system (☞ Fig. 4.5.1).

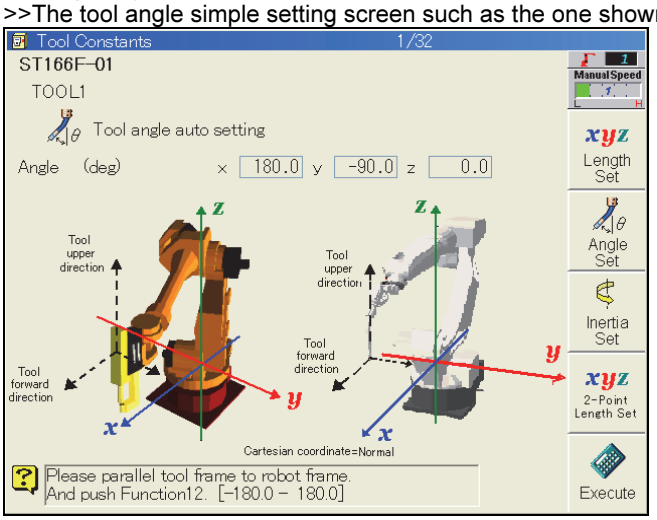
The operations involved will be facilitated if the upward direction of the tool is set as the Z (up) direction and its forward direction is set as the X (forward) direction since these are the directions used with the robot coordinates. The tool angle is what defines the tool coordinate so that this is achieved.

The tool angle setting is referenced in the operating direction when manually operating the tool coordinate system, [services: program conversion: parallel shift], etc., so be sure to set it. Also, if you are using a arm (arm Direction) that requires servo gun bent compensation control of the gun (Servo Driven spot welding gun), the tool angle will directly orient the bent compensation, so the tool angle setting is still required.

Since it is often difficult to measure the tool angle, the following simple setting function has been provided. Follow the setting procedure below.

Simply setting the tool angle

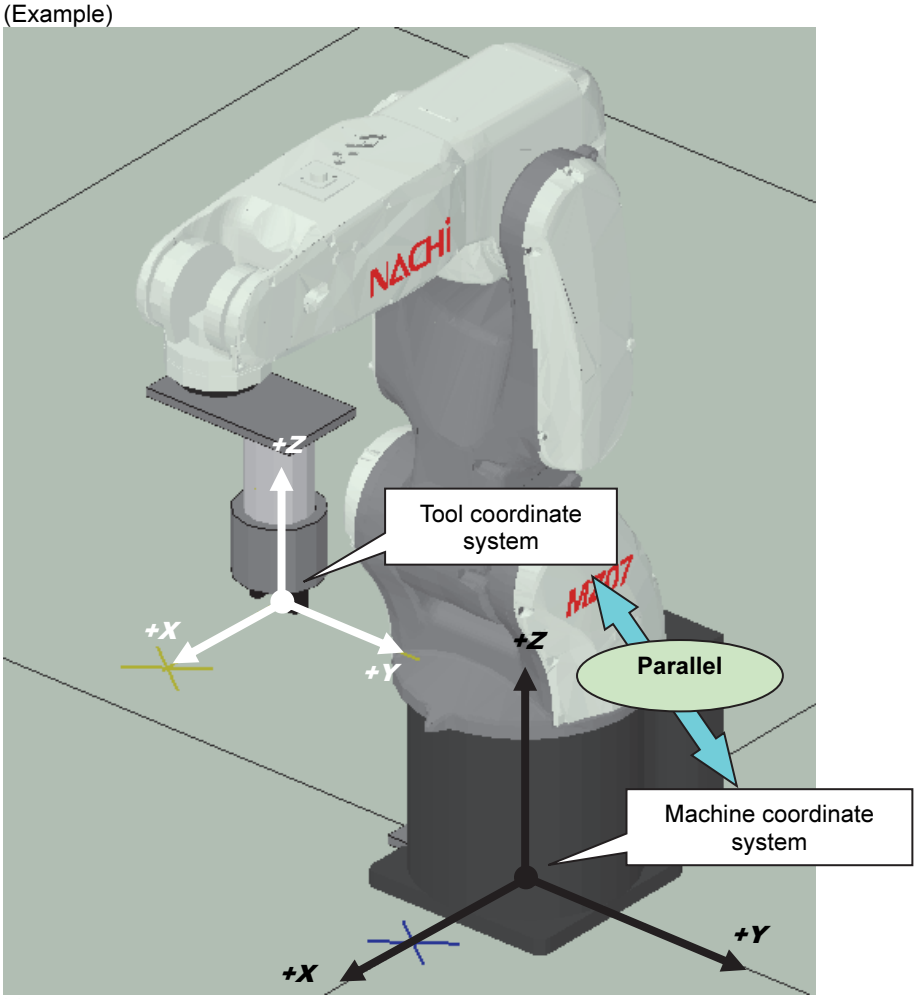
1 **On the tool constant setting screen for the desired tool number, press the <Easy Setting> key.**
>>The tool angle simple setting screen such as the one shown below now appears.



2 **If any other screen has appeared, press the <Angle Set> key.**

3 **As per the guide picture, visually align the upward direction of the tool with the Z (up) direction of the robot and its forward direction with the X (forward) direction of the robot.**

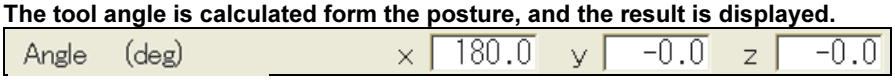
(Example)



※Robot on this picture is just an example for the explanation. It does not coincide with the actual robot.

4 **Press the <Execute> key.**

5 **The tool angle is calculated form the posture, and the result is displayed.**



The angle of rotation is now calculated so that the tool upward direction in the tool coordinate system is set to the Z (up) direction and its forward direction is set to the X (forward) direction.
If this is satisfactory, select [Yes] on the pop-up window, and press the [Enter] key.
>>At this stage, only the display is updated, and the data is not yet stored in the constant file.
To set the value accurately, it is also possible to re-enter the value of 180.0 manually instead of 179.4 for example.

6 **Upon completion of the settings, press the <Complete> key. The settings are now saved in the constant file.**
>>Operation returns to the machine constant menu screen.

7 **Upon completion of the settings, check them. Exit the constant menu and, in the teach mode, select the tool coordinates and try performing manual operations.**
If the tool is now moved in the up/down direction by the Z key and in the front/back direction by the X key, then the tool angle has been set successfully.

4.5.4 Center of gravity (COG) and weight of tool

CAUTION

The tool center of gravity (COG) and weight are parameters required to exercise the appropriate acceleration/deceleration control.
After installing all the tools, arm loads, etc., it is absolutely necessary to set the tool center of gravity and weight.

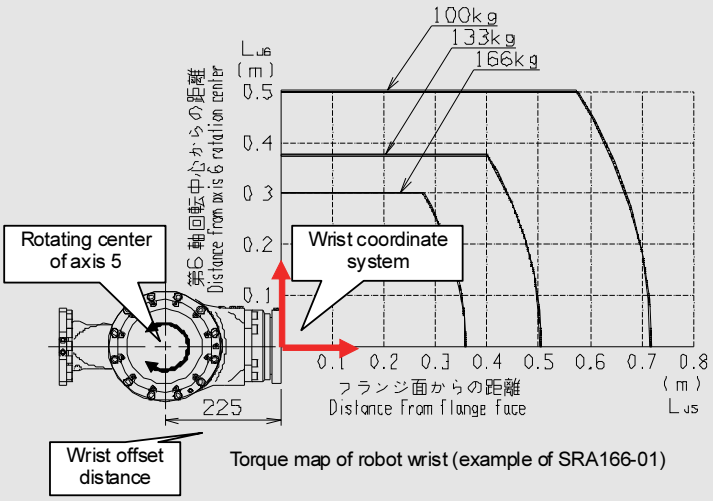
Tool COG is defined as the position of COG on wrist coordinate system (Fig. 4.5.1).

The tool weight cannot be input manually on the tool constant setting screen. This is to avoid the danger of seriously damaging the machine which would result if a weight which is considerably different from the actual weight has been set by mistake. At the factory, the value of the rated conveyable weight was set. (The tool center of gravity can be input.)
Therefore, this controller can automatically calculate the correct values for the center of gravity (COG) and weight of tool. Use this convenient function to set the center of gravity (COG) and weight of tool.

IMPORTANT

The torque which is calculated from COG position and weight set here can not be directly compared with “allowable static load torque” written in robot specification sheet.

The COG position set here is defined on wrist coordinate system (whose origin is the center of wrist flange). “Allowable static load torque” written in robot specification sheet is the ability of robot wrist (axis 4, 5 and 6).
Before comparing them, wrist offset distance (225mm in sample drawing below) must be considered and torque needs to be calculated again.



Torque map of robot wrist (example of SRA166-01)

For the **tool center of gravity and weight setting function** described next to be used, the basic teaching and playback check jobs must be performed. Since these jobs cannot be done if the Basic Operations Manual hasn't been read yet, do not set the center of gravity (COG) and weight of tool but use the initial settings as is and continue until the end of the setup is reached.
After reading the Basic Operations Manual, proceed with these settings again without fail.

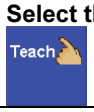
Setting the center of gravity (COG) and weight of tool automatically

Operate the robot in a predetermined manner, calculate the torque generated from the current at this time, and use the measured value as a basis to calculate the center of gravity (COG) and weight of tool. Although one program for sampling the current must be taught, the center of gravity (COG) and weight of tool can then be set simply by playing back the program.

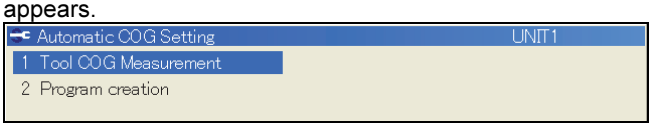
For this procedure, the operator class must be ***EXPERT*** or higher.
page4-61 『4.7 Operator class (Operator Qualifications』

(1) Create the program for measuring the center of gravity (COG) and weight of tool

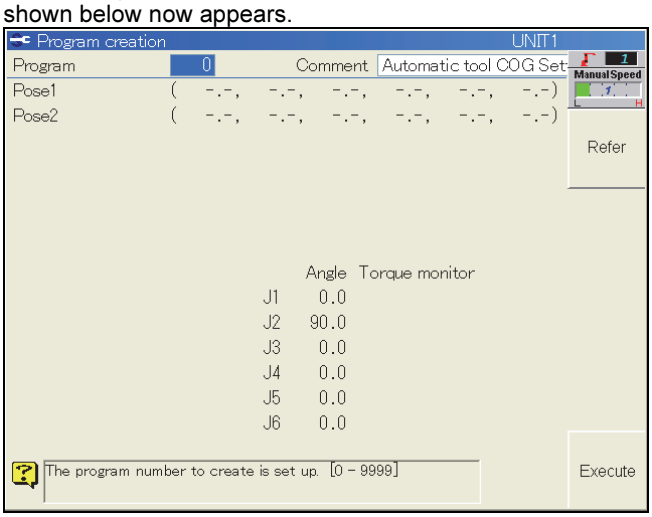
1 **Select the teach mode.**



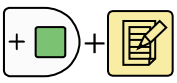
2 **First, the program for the center of gravity (COG) and weight of tool setting function must be taught. Select [Automatic COG Setting] from <Service Utilities>.**
>>An automatic center of gravity setting screen such as the one shown below now appears.

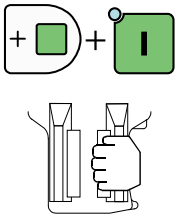


3 **Select [Program creation] from the menu items.**
>>The program creation screen for the auto tool load center setting such as the one shown below now appears.



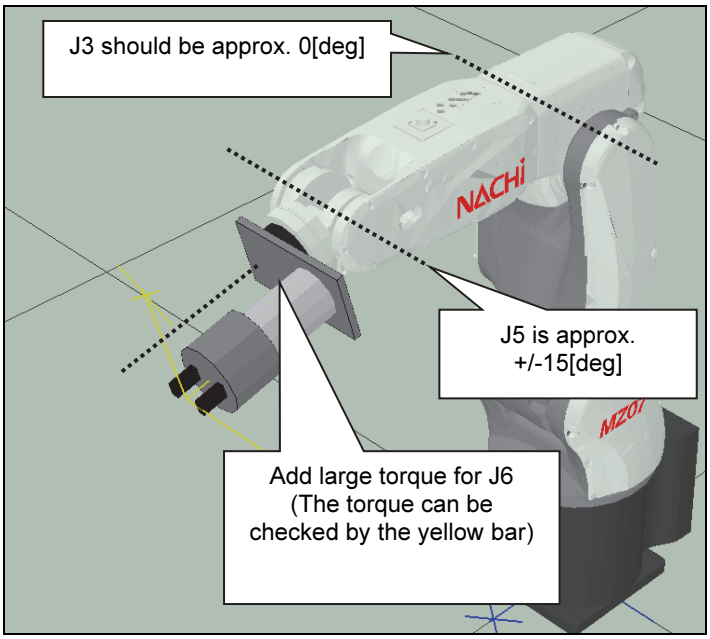
4 **First, align the cursor with the program No., input here the number of a program which is not currently being used, and press the [Enter] key.**
>>This is the number of the program which will now be created for automatically setting the center of gravity (COG) and weight of tool. An unused number must be specified here without fail.
It is also possible to input a comment directly from this setting screen.
Align the cursor with the comment field, and press the [ENABLE] + [EDIT] keys.
The soft keyboard appears so that a comment can be registered.

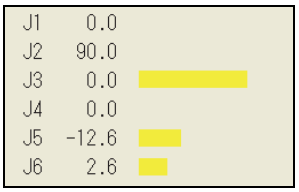




5 **Switch on the motor power, and use the axis operating keys to operate the robot and set it to a posture in which an unbalanced torque (load resulting from the effect of the gravity) is applied to the J3, J5 and J6 axes.**

>>The posture shown in the figure below, for instance, is ideal. At this time, any posture of J1 and J2 axes does not matter. The torque of each axis is displayed as a bar graph on the torque monitor at the bottom right of the screen. A posture in which the bar graph is the longest for the J3, J5 and J6 axes is the ideal one. However, pay particular attention to the resulting movements of the cables since a posture in which tension is applied to the application cable or which causes the cables to rub against the robot body will adversely affect the accuracy.





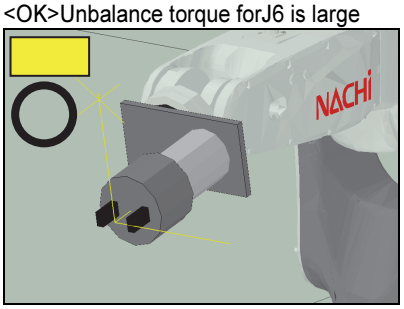
J3,J5,J6 torque bar should be long

The Torque monitor (bar graph) displays the torque as a ratio to the stalling current of each axis motor. The higher is this ratio, the greater will be the unbalanced torque which is applied and the better suited will be the posture to the automatic center of gravity (COG) and weight of tool settings

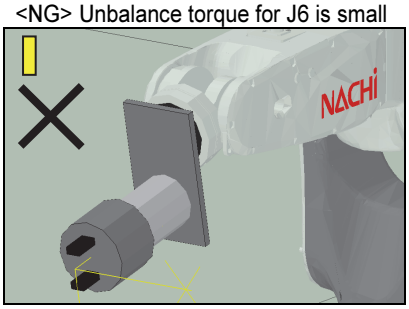
(Supplement for J6 axis)

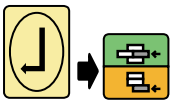
If the COG (center of gravity) of the tool is not on the rotational center axis of the J6, please use the posture like the following picture. If the COG in on the rotational center axis, the angle does not matter.

<OK>Unbalance torque forJ6 is large

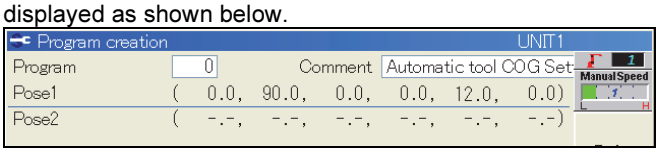


<NG> Unbalance torque for J6 is small

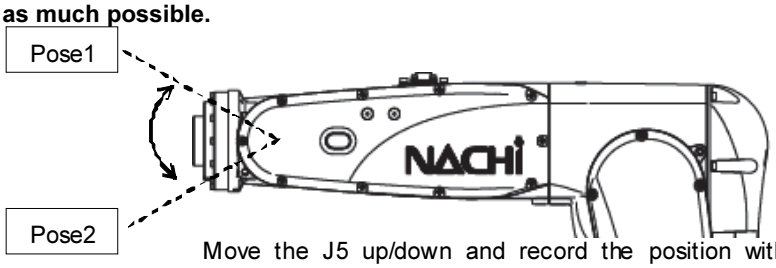




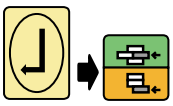
6 **Align the cursor with the Pose 1 field, and press the [Enter] key and [O.WRITE/ REC] key.**
>>The first posture (Pose 1) is now registered. The angle data loaded for the axes is displayed as shown below.



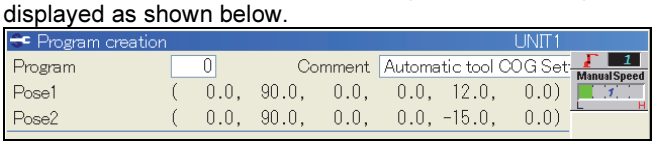
7 **Next, make a major change to the posture. At this time, change the wrist posture as much possible.**



Move the J5 up/down and record the position with unbalance torque is being added to the J3 and J6



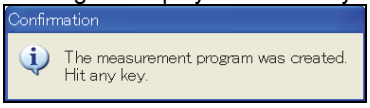
8 **Align the cursor with the Pose 2 field, and press [Enter] key and [REC] key.**
>>The first posture (Pose 2) is now registered. The angle data loaded for the axes is displayed as shown below.



9 **This completes the registration of two of the points required. Press the f12 <Execute> key.**
>>Based on the two postures registered in this way, the program shown below consisting of a multiple number of steps for initiating the automatic center of gravity (COG) and weight of tool settings is now generated automatically. The program No. which is automatically generated at this time is the one which was specified in 4.

1	Comment data
2	Pose 1 point
3	Point where J6 axis is positioned when it has moved by 10 degrees
4	Pose 1 point
5	Point where J5 axis is positioned when it has moved by 10 degrees
6	Pose 1 point
7	Point where J3 axis is positioned when it has moved by 10 degrees
8	Pose 1 point
9	Pose 2 point
10	Point where J6 axis is positioned when it has moved by 10 degrees
11	Pose 2 point
12	Point where J5 axis is positioned when it has moved by 10 degrees
13	Pose 2 point
14	Point where J3 axis is positioned when it has moved by 10 degrees
15	Pose 2 point
16	END instruction

>>Upon completion of the automatic generation of the program, the following pop-up message is displayed. Press any key.



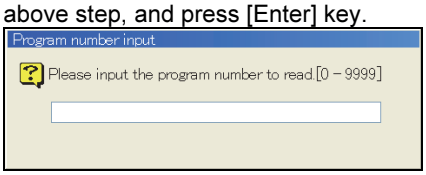
The poses (robot positions) were recorded directly by following the instructions set forth above, but an alternative to this is to teach a program in which these positions have been recorded ahead of time, and then call that program.
Since a program can be used over and over again once it has been taught, this method is preferable in cases such as a tool change application where the work involved in setting the center of gravity and weight

will be repeated for a number of different types of tools.

10 **First, record the program in which two positions are included.**
The same precautions described above apply to the robot positions and postures. The interpolation type, speed, accuracy, tool numbers, etc. may be disregarded at this point. Only the positions are referenced.

Refer

11 **Press the f8 <Refer> key without recording poses 1 (or 2) in 5 to 8.**
>>A dialog box shown below is displayed. Input the program number prepared in above step, and press [Enter] key.



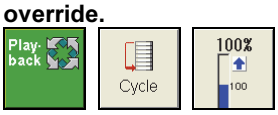
12 **First two move steps are loaded from the program, and the angle data of each axis is displayed.**
>>Even when functions were recorded in the program, they're ignored. Only the move command will be picked up.

13 **The procedure is now the same as in 9.**

(2) Executing the center of gravity (COG) and weight of tool settings

14 **Finally, measure the center of gravity (COG) and weight of the tool.**
"The program for measuring the center of gravity (COG) and weight of tool" which was created before must now be executed.

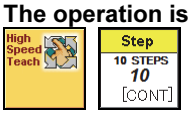
(Execute the measurement in the playback mode)
Switch to the playback mode and select the single cycle mode with 100% speed override.



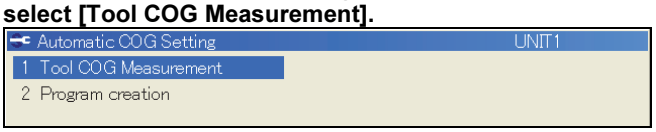
(Execute the measurement in the teach mode)
It is possible to execute this measurement function in the teach mode also.

Enable the "Continue" mode using the [Stop/Continue]  key.

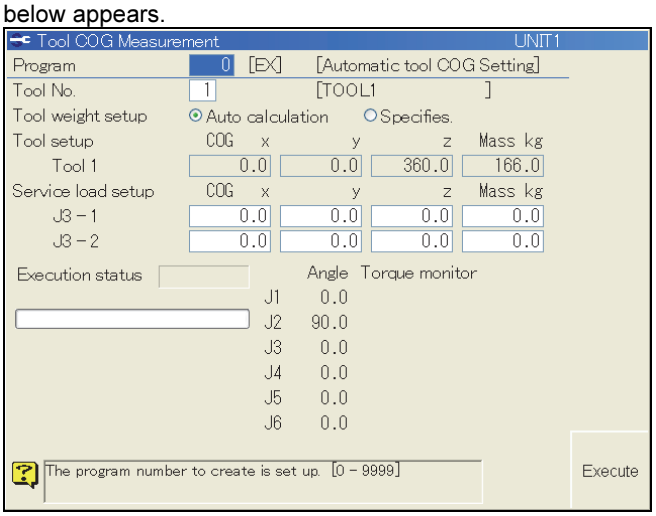
(High-speed teach mode (option))
The operation is the same with the teach mode.



15 **Select [Automatic COG setting] from <Service Utilities> as before, and then select [Tool COG Measurement].**



>>The screen for executing the automatic tool COG setting such as the one shown below appears.

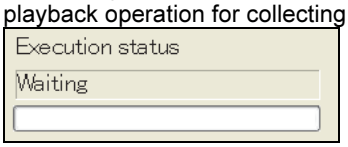


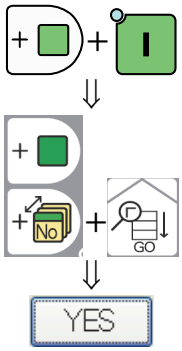
16 **Input the number of the program for measuring the center of gravity (COG) and weight of tool in the "Program" item.**
Input the tool number (1 to 32) to be measured in the "Tool No." item.
>>When the tool number is input, the center of gravity position (mm or inches) and weight (kg) of that tool which are currently registered in the constants are displayed.

17 **In some cases such as when a new spot welding gun is used, the tool weight is already known. In such a case, align the [Tool weight setup] item with <Specifies> and set the known tool weight in kilograms in the "Mass" input field. Normally, the item is aligned with <Auto calculation>.**

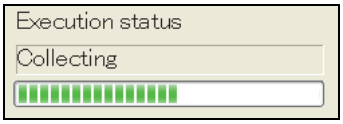
18 **When J3 axis carries a load such as a valve box and its center of gravity position and weight are known, input up to two of these values in the <Service load setup> field.**
>>If the service load is not known, there is no need to set it. The center of gravity (COG) and weight of tool setting function measures the tool and service load together (as if the load were concentrated on the tool).
If service load is set beforehand, those data is displayed. Please refer to “4.4 User load (service load) setting” for detail.

19 **Press the f12 <Execute> key.**
>>"Waiting" appears as the execution status. This indicates the status in which the playback operation for collecting the current data is awaited.





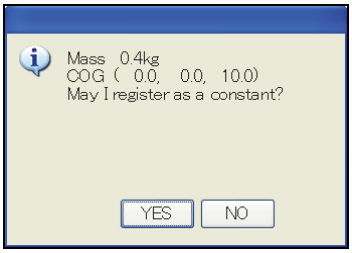
20 **Switch on the motor power, and start the program.**
>>The program whose number was specified in 16 now starts. The operating speed is the low safety speed. While the current data is being collected, the "Collecting" appears as the execution status, and the progress made is indicated on the progress bar.

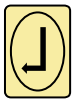


(In case of Playback mode)
>>The playback operation stops automatically after one cycle.

(In case of Teach mode)
Keep pressing the check go key until the program reaches its end step.
When the program stops in halfway, restart the operation from the Procedure 14.

21 **Upon completion of the program, the tool center of gravity and weight are obtained on the basis of the sampled current data, and the results are displayed as shown below.**





22 **Select [YES] using the cursor keys, and press [Enter] key.**
>>As soon as the [Enter] key is pressed, the data is saved in the constant file.
>>If the "The weight of the tool is too heavy . Please lighten." message appears at the same time as the measurement results, it means that the tool weight exceeds 100% of the rated conveyable weight. Check the installed tool, and reduce the weight so that it becomes less than the rated conveyable weight. (The data of the center of gravity (COG) and weight of tool are registered irrespective of the alarm message.)

23 **This now completes the measurement of the center of gravity (COG) and weight of tool.**
The results have been saved in the constant file.
Switch off the motor power by pressing the [Emergency Stop Button].

CAUTION

・In both case that “registered value on tool constant setting screen” exceeds beyond the allowable specification and that “real tool weight and COG” exceeds beyond the allowable specification, WE CANNOT GUARANTEE THE FUNCTION OF THE ROBOT.

・Also in case that “registered value on tool constant setting screen” and “real tool weight and COG” is much different (e.g. error of 20% or more), WE CANNOT GUARANTEE THE FUNCTION OF THE ROBOT. (For example, real tool is much lighter / heavier than the registered value, the plus and minus sign of the coordinates is reversed, and or so.)

・In case of material handling specification, tool weight and COG may vary depending on “tool only” or “tool + work piece“. We recommend to use individual tool number for each (e.g. TOOl1=”tool only”, TOOL2= “tool + work piece”). But, please be sure to set the tool number correctly in the move command. If the wrong tool number is recorded, the same problem mentioned as above will occur because “registered value on tool constant” and “real tool weight and COG” becomes much different.

・If the automatic COG setting function cannot be performed with grasping tool, and or so), calculate the coordinates of the COG by referring to the drawings etc. and set the parameters manually using the teach pendant.

CAUTION

In case of “using robot in the condition, which setting value and actual load (Weight/ COG) are largely different”, then it’s out of warranty. Some examples are shown below.

(Eg.1) Use the robot under circumstances that neglecting the warning message indicated, when completing measurement of Automatic COG function.
(Eg.2) Tool was replaced after conduct setting at Automatic COG function.
(Eg.3) Install the tool, which is extremely heavier than the set value.
(Eg.4) Install the tool, which is extremely lighter than the set value.
(Eg.5) Install the tool, where the barycentric coordinates is extremely far from rotate center than set value.
(Eg.6) Use the robot without using automatic COG function.
..And so on.

In this kind of situation, there are some possibilities to raise phenomena as below.

Shorten robot life cycle, Cannot conduct right servo control, Tool vibrates, Huge difference between the cycle time at simulation and actual cycle time etc.

CAUTION

There is a case of installing the over-rated weight tool and set its weight with numerical value under the condition, which regulates wrist angle, motion range, speed etc. than standard specification However, such operation is deprecated and requires having discussion with our NACHI technical department for sure. In case of using the robot, which is beyond its load or setting, then it is out of warranty without our company agreement or permission.

4.5.5 Tool's moment of inertia

CAUTION

The tool's moment of inertia must be set without fail if it exceeds the allowable level of the wrist.
Just as with the center of gravity (COG) and weight of tool, the machine may be fatally damaged if the setting for the moment of inertia is different from the actual value.

(supplement) In case that long tool must be rotated quickly, generated moment of inertia sometimes becomes bigger than the permitted level of wrist joint. Robot speed needs to be changed slower (each step speed needs to be modified) to reduce damage to the robot. But if tool's moment of inertia is set properly here, robot speed is every time controlled properly by software.

CAUTION

Before using this function, the tool weight and COG (center of gravity) position must be set in the tool constants correctly. Inexact settings for the tool weight and center of gravity position may drastically reduce the identification accuracy of the moment of inertia and adversely affect the performance and service life of the robot.

IMPORTANT

For the automatic inertia setting procedure, the operator class must be ***EXPERT*** or higher.
"4.7 Operator class (Operator Qualifications"

IMPORTANT

Tool's moment of inertia set here is different from "allowable moment of inertia" written in robot specification sheet.
Please refer to "Manual calculation" on next page.

Tool's moment of inertia is defined on the coordinate system whose origin is the COG of tool. Beware that this coordinate system is different from wrist coordinate system (Fig. 4.5.1).

There are 3 methods to set the moment of inertia.

Function / Item	Simplified setting (registration of tool shape)	Automatic setting function	Manual calculation
Estimated accuracy	• High error with complex shapes. • Not affected by size. • Variations in the values calculated due to variations in the external dimensions arising with different operators.	• Not dependent upon the tool shape. • Since it is automatic, variations arise with different operators. • The accuracy is diminished with a low moment of inertia which is less than 40% of the specification.	• Not dependent upon the shape or size. • The accuracy is high but since it is dependent upon the number of divisions, variations arise with different operators.
Required Time	30 to 60 sec.	2 to 3 minutes	2 to 3 hours
What to have ready	External dimensions based on tool or drawings	Tool Measurement program	Drawing

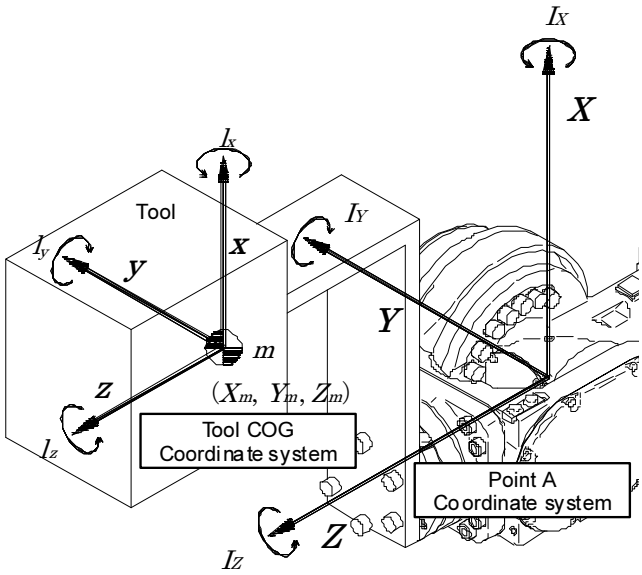
< Recommended Procedure >

(1) Regard tool as one prism, and calculate its rough moment of inertia by using "Simplified setting".
(2) If result is larger than 40% of specification and tool shape is complicated, calculate the precise moment of inertia by using "Automatic setting function".
(3) If result is less than 40% of specification and tool shape is complicated, calculate the precise moment of inertia by using "Manual calculation".

IMPORTANT

If tool moment of inertia was too small, result of "Automatic setting function" may fall in "0" sometimes.
In such case, set it by using "Manual calculation"" or "Simplified setting".

Manual calculation

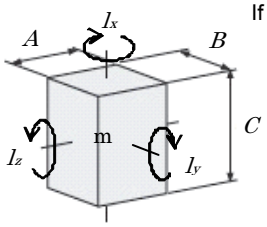
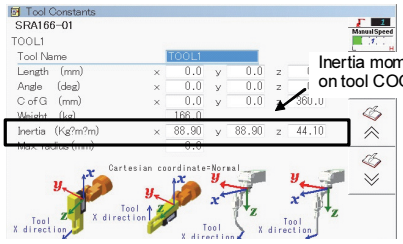


Point A coordinate system
Origin is Point A (intersection point of axis 6, 4 rotation center and axis 5 rotation center) and its X, Y and Z direction are defined as
- X: Perpendicular coordinate with Y, Z
- Y: Axis 5 rotation center when wrist is in reference position
- Z: Axis 6 and 4 rotation center when wrist is in reference position

Tool COG coordinate system
Origin is COG of tool, and parallel to point A coordinate system
- x: Parallel to X
- y: Parallel to Y
- z: Parallel to Z

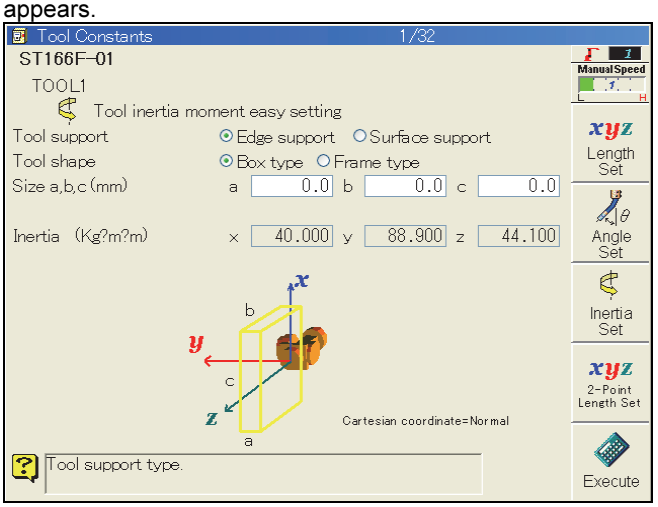
Inertia moment
- I_X: Around X on point A coordinate system
- I_Y: Around Y on point A coordinate system
- I_Z: Around Z on point A coordinate system
- I_x: Around x on tool COG coordinate system
- I_y: Around y on tool COG coordinate system
- I_z: Around z on tool COG coordinate system

m: Tool mass
(Xm, Ym, Zm) : COG of tool on point A coordinate system

1	Calculate inertia moment defined on tool COG coordinate system (***xyz***). If tool is regarded as prism, it is calculated as right formula.	Inertia moment example on tool COG coordinate system  If tool is regarded as prism $I_x = \frac{1}{12} m \cdot (A^2 + B^2)$ $I_y = \frac{1}{12} m \cdot (A^2 + C^2)$ $I_z = \frac{1}{12} m \cdot (B^2 + C^2)$ These values (I_x, I_y, I_z) are registered to controller.  Inertia moment on tool COG coordinate system This is different from "allowable moment of inertia" written in robot specification sheet.
2	Calculate inertia moment defined on point A coordinate system (***XYZ***), then calculate inertia moment around robot wrist joint (axis 4, 5 and 6). This result must not be larger than "Allowable moment of inertia" written in robot specification sheet.	Inertia moment on point A coordinate system (***XYZ***) is $I_X = m \cdot (Y_m^{\ 2} + Z_m^{\ 2}) + I_x$ $I_Y = m \cdot (X_m^{\ 2} + Z_m^{\ 2}) + I_y$ $I_Z = m \cdot (X_m^{\ 2} + Y_m^{\ 2}) + I_z$ Axis 4 and 5 inertia moment is larger value of I_X and I_Y, because this depends on axis 6 position. Axis 6 inertia moment is I_Z itself. $I_{J4} = I_{J5} = \max(I_X, I_Y)$ $I_{J6} = I_Z$

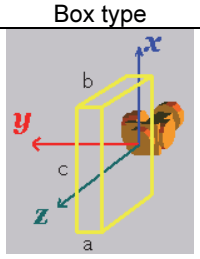
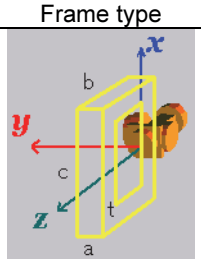
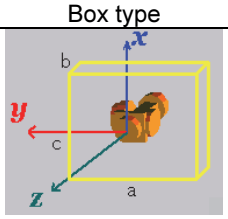
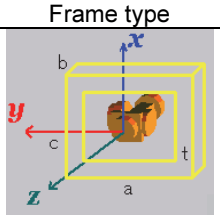
Simplified setting procedures for the tool moment of inertia (registration of shape)

1 **On the tool constant setting screen for the desired tool number, press the <Easy Setting> key.**
>>The tool moment of inertia simple setting screen such as the one shown below now appears.



2 **If any other screen has appeared, press the <Inertia Set> key.**

3 **As per the guide picture, select the tool designation direction and tool shape, and input the width, depth, height and sheet thickness.**
>>Select from among the four patterns the shape that is thought to most closely represent the shape of the installed tool.

End support Box type	End support Frame type	Face support Box type	Face support Frame type
			

4 **Press the <Execute> key.**
>>A message whether the tool center of gravity and weight setting has been completed or not is displayed. If it has not completed yet, select "No" and exit this setting screen, and first carry out the center of gravity and weight setting.

5 **The results of the moment of inertia calculation are now displayed. If this is satisfactory, select [Yes] on the pop-up window, and press the [Enter] key. When the dimensions have been input incorrectly, select [No]. They can now be input again from the start.**
>>At this stage, only the display is updated, and the data is not yet stored in the constant file.

6 **Upon completion of the settings, press the <Complete> key. The settings are now saved in the constant file.**
>>Operation returns to the machine constant menu screen.

7 **At this time, “Mode” setting in the “Interference setting” screen will be changed to “Normal sensitive” automatically.**
(See “4.9.4“Interference setting” screen”)

Automatic setting of tool moment of inertia

This function is useful when tool shape is complex or moment of inertia is big.
At first prepare three programs, and playback them one by one. Then controller calculates the tool moment of inertia (X, Y and Z).

Before starting measurement of the tool moment of inertia, press the "Mechanism" key on the teach pendant, and select the target mechanism for the system with multiple manipulators.

(1) Prepare three measurement programs

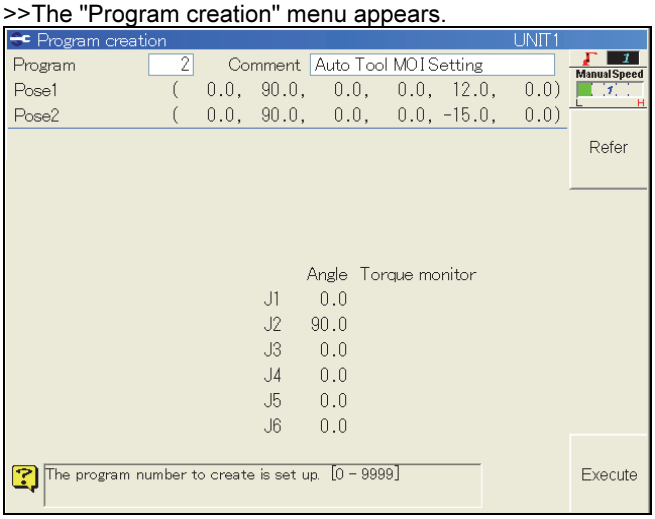
At first, create the measurement program. One measurement program can get the result of only one component of tool moment of inertia (X or Y or Z). So in order to get the all components of tool moment of inertia, three measurement programs are necessary.

1 **Select the teach mode.**
>>Automatic measurement programs can be prepared only in the teach mode or 1-step playback mode.

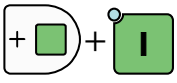
2 **Press [RESET/R], [2], [9] and [Enter].**
Dialog box to input the tool number is now opened. Input the tool number to be selected and press [Enter] key.
>>The tool number selected here is recorded in the measurement program.

3 **Set the operator class to *EXPERT* or higher.**

4 **Press <Service Utilities> - [30 Automatic moment of inertia] – [2 Program creation].**
>>The "Program creation" menu appears.



5 **Move the cursor to the "Program," input the number of the program which is to be used as the automatic measurement program, and press the [Enter] key.**
>>The comment function is automatically recorded at the head of the automatic measurement program, and this can be changed as required.
In order to identify whether the tool rotates around the X, Y or Z axis, the differentiation between the X, Y and Z axes is automatically recognized from the poses at two recorded points, and the letter "X," "Y" or "Z" is automatically added onto the end of the comment which is recorded in the automatic measurement program.



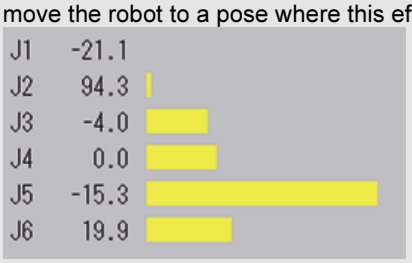
6 **Two poses are necessary for the automatic measurement program.**
Turn on the motor power and move the robot manually to the target poses while taking care that the robot and tool will not interfere with the nearby equipment.

In order to obtain a satisfactorily accurate tool moment of inertia, bear in mind the following points when deciding on the pose.

POINT

• Move the robot in such a way that one axis among J4, J5 and J6 axes will turn around the X, Y or Z axis of the tool coordinate system. If possible, use only J5 or J6 axis.
• Ensure that a wide operating range is provided. (An angle of 60 degrees or more is recommended.)
• Minimize the effects of gravity.

Use a torque monitor to check the effects of gravity.
If the deflection of the torque monitor pointer is significant while the robot is in the hold status, this indicates that gravity is exerting an effect so move the robot to a pose where this effect is reduced.

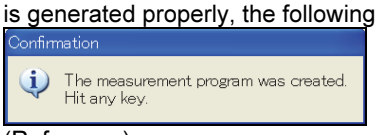


By the phrase "while the robot is in the hold status" is meant the state in which the motor power is ON but the robot is at a halt(“Servo lock state”). Take care when the robot is operated since the torque monitor pointer will deflect significantly due to the operation.

7 **Move the robot to Pose 1. Align the cursor to “pose1” and press [Enter] key.**

8 **Move the robot to Pose 2. Align the cursor to “pose2” and press [Enter] key.**
Rotate wrist axes in order that pose 1 and pose 2 differs more than 60 degrees in wrist axes.

9 **Finally, press f12 <Execute> key.**
>>Based on the recorded poses, measuring program is generated. When the program is generated properly, the following confirmation dialog box appears.

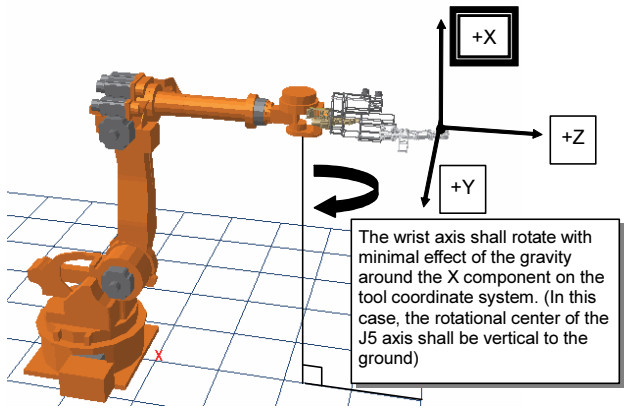
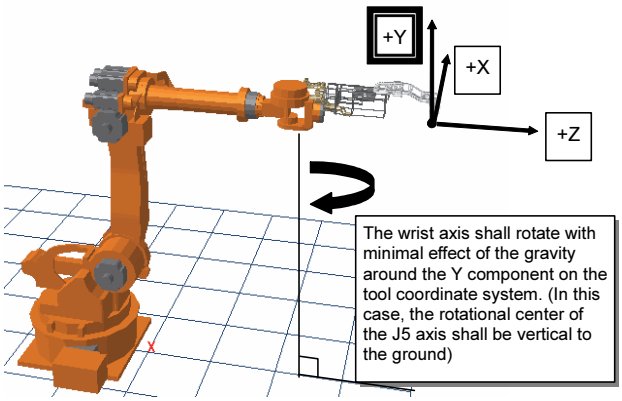
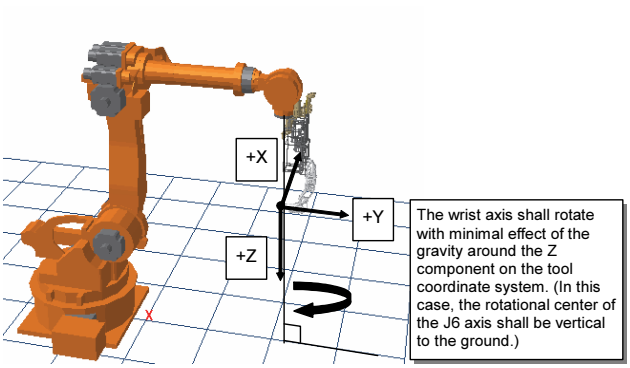
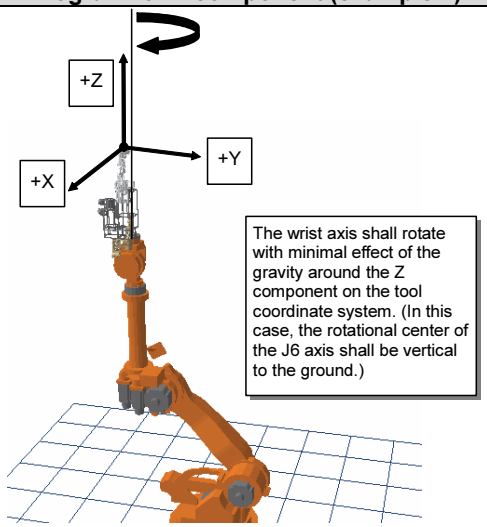


(Reference)
“X” or “Y” or “Z” is automatically added as the last character of comment. (This X/Y/Z direction is automatically determined from the recorded two postures.)

10 **Press [RESET/R] key to return to the service utilities menu.**
In same way, create three measuring programs.

See following figures as sample.

Table 4.5.2 Preparing measurement positions

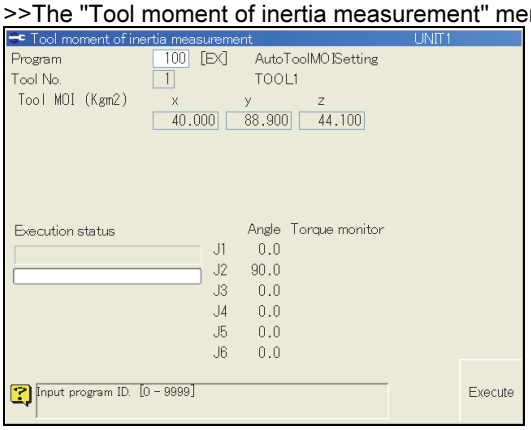
Program for X component	Program for Y component
 **<Angle of each axis (J1,J2,J3,J4,J5,J6)>** POSE1 : (0, 90, 0, -90, 0, 90) POSE2 : (0, 90, 0, -90, -90, 90)	 **<Angle of each axis (J1,J2,J3,J4,J5,J6)>** POSE1 : (0, 90, 0, -90, 0, 0) POSE2 : (0, 90, 0, -90, -90, 0)
Program for Z component (example 1)	**Program for Z component (example 2)**
 **<Angle of each axis (J1,J2,J3,J4,J5,J6)>** POSE1 : (0, 90, 0, 0, -90, -90) POSE2 : (0, 90, 0, 0, -90, 0)	 **<Angle of each axis (J1,J2,J3,J4,J5,J6)>** POSE1 : (0,135, 45, 0, 0, 90) POSE2 : (0,135, 45, 0, 0, 0)

(Reference)
Taught program can be utilized to create the measuring program.
Press f8 <Refer>. Then input the taught program number and press [Enter] key. First move step is used as pose 1 and second move step is used as pose 2.

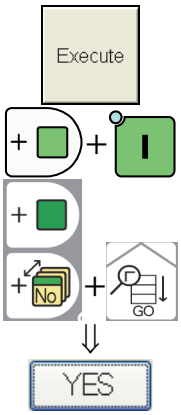
(2) Measuring the tool moment of inertia

11 **After preparing three measuring programs,**
Set the [MODE SELECT SWITCH] on the operation panel to "Playback."
>>The "Moment of inertia measurement" menu can be opened only in one cycle playback mode.
Specify the tool number of the tool whose moment of inertia is to be measured by proceeding as in step 2.
Operator class must be *EXPERT* or higher.
For the system with multiple manipulators, press the "Mechanism" key on the teach pendant, and select the mechanism that you measure the tool moment of inertia.

12 **Press <Service Utilities> - [30 Automatic moment of inertia] – [1 Tool moment of inertia measurement].**
>>The "Tool moment of inertia measurement" menu appears.



13 **Move the cursor to "Program," input the number of the automatic measurement program which has been prepared, and press the [Enter] key.**



14 **Press the f12 <Execute> key.**
>>The execution status changes to "Waiting to gather data."

15 **Turn on the motor power.**

16 **Start.**
>>Now automatic measurement of tool moment of inertia starts.

POINT

Take sufficient care to ensure that the robot and tool do not interfere with the nearby equipment. If the robot overshoots during playback, reduce the speed override.

>>After automatic measurement of tool moment of inertia is completed, a confirmation dialog box appears.

17 **A dialog box on which to check the calculation results now appears.**
Select "Yes" to register the calculation results in the constants or "No" to cancel.

18 **Press [RESET/R] key to return to the service utilities menu.**

Repeat the playback operation for the respective axis x, y and z by following the same procedures.

19 **Finally, play back the movements where the tool rotates at high speed and check that there is no overshooting, etc.**

20 **To use the High-speed interference detection function, change the setting of "Mode" to "Normal sensitive" in the screen of "Interference detection" screen. (See "4.9.4"Interference setting" screen")**

(3) Trouble which may occur while the tool moment of inertia is being measured and troubleshooting procedures

Phenomena	Troubleshoot
The robot overshoots during playback.	If the automatic measurement program is played back while a tool having an excessively high moment of inertia is installed on the robot, the robot may overshoot (move beyond the recorded point and then return) or trouble may simultaneously occur. [Countermeasure] Reduce the override for the playback. If the measurement is undertaken with the override reduced, however, the accuracy with which the moment of inertia is calculated will deteriorate.
The moment of inertia cannot be measured with the work gripped by the tool.	[Countermeasure] (1) Obtain the moment of inertia of the work by calculating it manually or registering the tool shape. (2) Obtain the moment of inertia minus the value for the work using the automatic setting of the tool moment of inertia. Now set a different tool number from the tool number in (1) as the tool whose moment of inertia is to be measured. (3) Select <Constant Setting> [3 Machine Constants] and [Tool Settings], and input the numerical values for the tool with work and without the work to register the moment of inertia.
A2699 Something is wrong with the results obtained by measuring for the automatic setting of the tool moment of inertia.	This trouble occurs when there is something wrong with the speed and current data which were gathered in order to calculate the tool moment of inertia. [Countermeasure] • Revise the teaching so that the movement amount will be greater. • Revise the teaching for the automatic measurement program so that effect of gravity will be minimized. • Revise the teaching so that only one axis, either the J5 axis or J6 axis, will move.
The pose used for the automatic setting of the tool moment of inertia is not appropriate.	This message appears when the two designated poses fall into any of the following categories: • When the axis targeted for the measurement moves through less than 30 degrees • When two or more axes move through 5 degrees or more • When an axis other than the J4, J5 or J6 axis moves through 5 degrees or more [Countermeasure] • Revise the teaching so that the movement amount will be greater. • Revise the teaching so that only one axis—J4, J5 or J6—will move.
This program is not used for the automatic setting of the tool moment of inertia.	This message appears when an attempt has been made to measure the tool moment of inertia by selecting a program which was prepared on a menu screen other than the "Program creation" menu for the automatic setting of the tool moment of inertia. [Countermeasure] Select a program which was prepared using the "Program preparation" menu item for the automatic settings of the tool moment of inertia.
The same filename exists.	This message appears when a program with the number which was designated in the "Program creation" menu item already exists. [Countermeasure] Designate the number of the program which is not yet used.
This step does not exist.	This message appears when the program referenced on the "Program creation" menu item does not have at least two movement steps. [Countermeasure] • Reference a program with at least two movement steps. • Move the robot manually, and designate a pose.

Switch the designated mechanism to a manipulator.	This message appears when an attempt has been made to open the "Program creation" menu and "Tool moment of inertia" menu in a situation where a multiple number of 6-axis multi-joint robots exist in one unit and the current mechanism is not a 6-axis multi-joint robot. [Countermeasure] First return to the mode screen, press the "Mechanism" key on the teach pendant, and switch the current mechanism to manipulator (6-axis multi-joint robot).
The wrong axis or mechanism has been specified.	This message appears in the following cases: • When the axis selected by the "Tool moment of inertia" menu to move in the program is not J4, J5 or J6 • When an attempt has been made to measure the moment of inertia on the "Tool moment of inertia" menu in a situation where a multiple number of 6-axis multi-joint robots exist in one unit and the current mechanism is not a 6- axis multi-joint robot [Countermeasure] • Revise the teaching so that only one axis—J4, J5 or J6—will move. • First return to the mode screen, press the "Mechanism" key on the teach pendant, and switch the current mechanism to manipulator (6-axis multi-joint robot).
The tool moment of inertia rating has been exceeded.	This message appears when the results of automatically measuring the tool moment of inertia and the value input for the tool moment of inertia on the Tool Settings" menu selected from <Constant Setting> - [3 Machine Constants] have exceeded the rating. When a robot with a tool having an excessively high moment of inertia is used, its performance and service life may be adversely affected. Furthermore, during playback the robot may overshoot (move beyond the recorded point and then return) or trouble may simultaneously occur. [Countermeasure] • Review the tool. • If there is no alternative to using the current tool, take remedial action by reducing the override or revising the teaching, for instance, and take sufficient care to ensure that the robot will not overshoot or no other trouble will occur.

4.5.6 Max, radius of tool

Set the maximum radius of tool rotation if the tool length (length up to the interpolation point) and the tool shape are significantly different as they are in the figure below. Use the radius of a sphere which encompasses all the space from the interpolation point as the center, up to the outermost circumference of the tool (including the work piece which is gripped in the case of a material handling tool) as the setting.

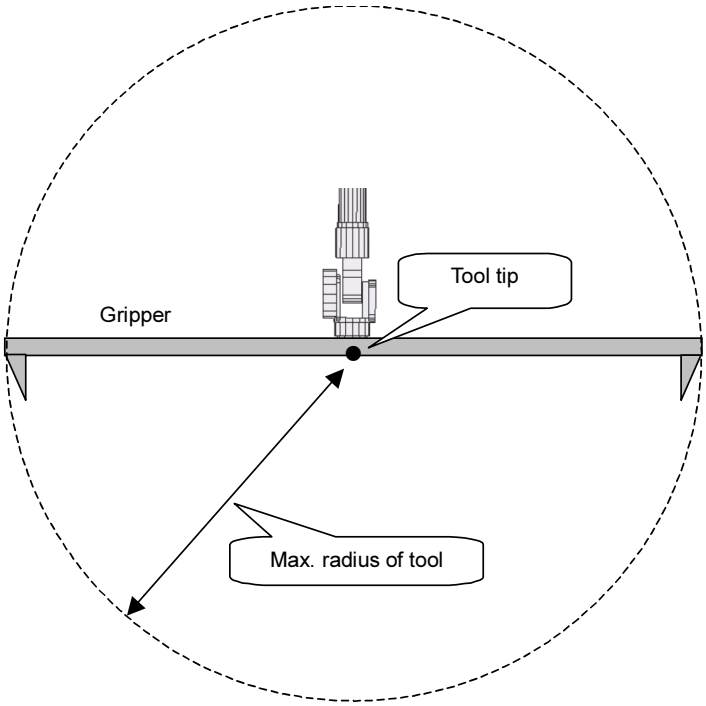
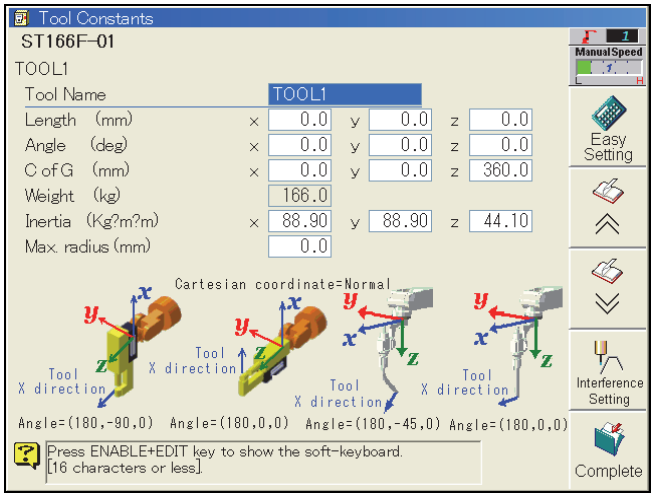


Fig. 4.5.2 Max. radius of tool

4.5.7 Tool conversion

In the case the tool shape deforms, an already taught task program will lose compatibility. It is necessary to convert the already taught task program so that the tool tip position and the target angle should be same as those before deformation.
When the settings of the tool length and the tool angle are changed, in order to keep the compatibility of already taught task program, the following tool conversion function is prepared. Convert the program according to the following procedures.

1 **After the settings of the tool length and the tool angle, press <Complete> key. The set contents are stored into the constant file.**

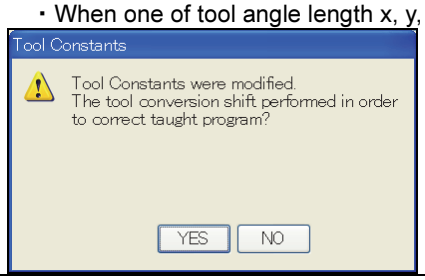


0

2 **When some of tool constants are changed, the following popup window is displayed.**

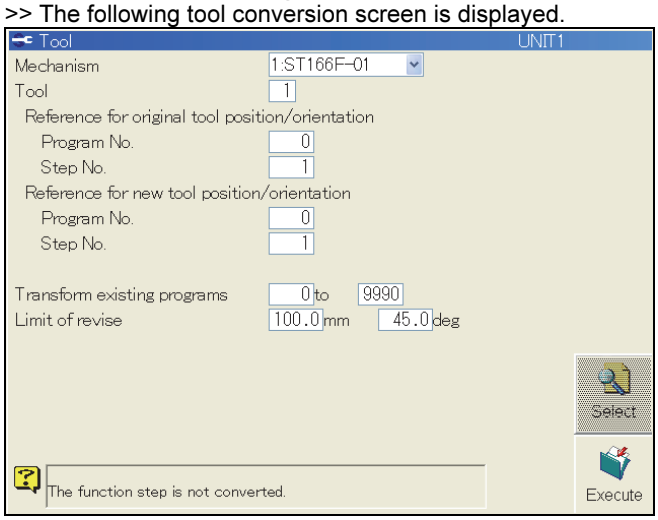
>> The change of tool constants can be checked by either of the following changes.

- When one of tool lengths x, y, and z has changed 0.05mm or more
- When one of tool angle length x, y, and z has changed 0.005deg or more



3 **When to convert the program, select [OK] and press [Enter] key.**

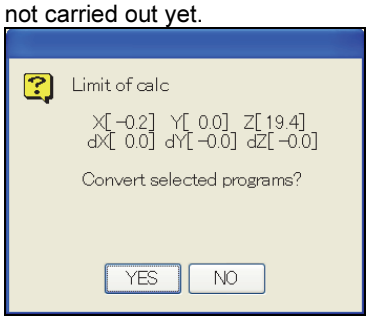
>> The following tool conversion screen is displayed.



When the 2-point tool length is set, the conducted mechanism and the tool number, and the program number and the step number showing referential points before and after conversion are succeeded to.

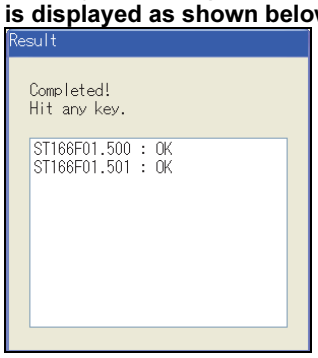
4 **Press <Execute> key.**

5 **The corrected value is calculated, and after a while, the result is displayed as shown below.**
>> At this time, only the corrected value is displayed, and the program conversion is not carried out yet.



If program conversion can be started, select [OK] and press [Enter] key.

6 **The objective programs are converted, and the result of the converted program is displayed as shown below.**



7 **After conversion of all the objective programs is completed, press [Enter] key.**
>> The screen goes back to the machine constant menu screen.

8 **After the conversion, carry out entire confirmation.**
Exit the constant menu, and run the program converted in the above 6 by check go/back in the teach mode.

The conversion is successful if the tool tip position and the target angle are same as those before deformation.

4.6 Signal attribute settings

This section describes the method used to set the signal attributes of this controller. The signal attributes can be classified differently as in the tables below.

Table 4.6.1 Types of signal attributes

	Signal attributes	Explanation
Classification by direction	**Input signal**	Signals which are input from external sources to the controller. They are also called "I" signals.
	Output signal	Signals which the controller outputs to external sources. They are also called "O" signals.

	Signal attributes	Explanation
Classification by application	**Status signal**	Signals with a predetermined significance such as the "start command" input signal for starting the robot and the "robot running" output signal which turns on during robot playback operations are called status signals. Many and varied signals are provided by the applications but those signals which are used as the standard signals and which are not dependent on applications are called **standard signal attributes**.
	General-purpose signals	These are signals which, for instance, can write ON/OFF commands freely in programs. Applications can be created freely by putting together the external sequences in the manner desired.

	Signal attributes	Explanation	
Classification by structure	**Logical signals**	This is a general term for signals which enable access from the software side.	If a **software PLC** is not going to be used, the logical signals are directly connected with physical signals in their original form. In this case, therefore, this classification may be ignored.
	Physical signals	This is a general term for signal attributes which have been connected with a DC 24V field bus or other external source.	

A total of 2,048 input signals and 2,048 output signals have been provided (total number of logical signals). On the other hand, the physical signals are restricted by the I/O form provided. For example, up to 32 inputs and 32 outputs are available when only one I/O board (option) is installed. All of 2,048 inputs and 2,048 outputs are available when DeviceNet (option) is installed
So the numbers of logical signals used as status signals can be set freely in order to fit the physical I/O capacity which is actually used. This is known as “signal attribute assignment”. At the factory, the standard assignment is set although this can easily be changed. Set the alternative assignment in accordance with the system design.

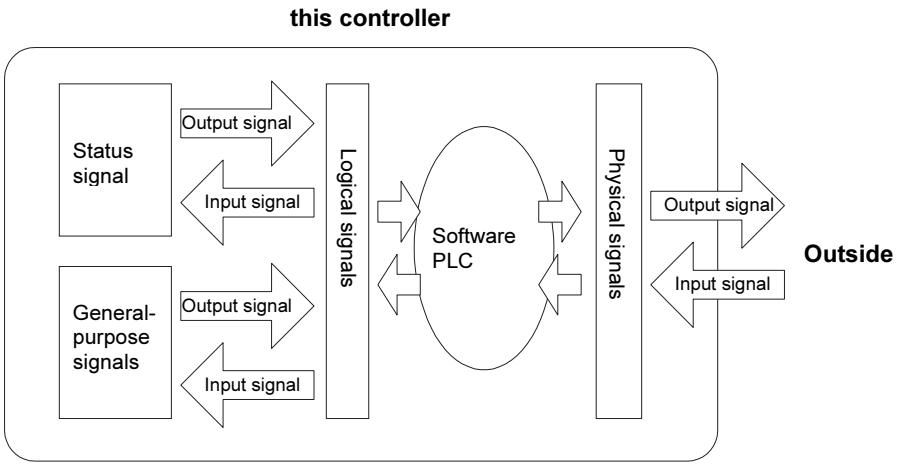
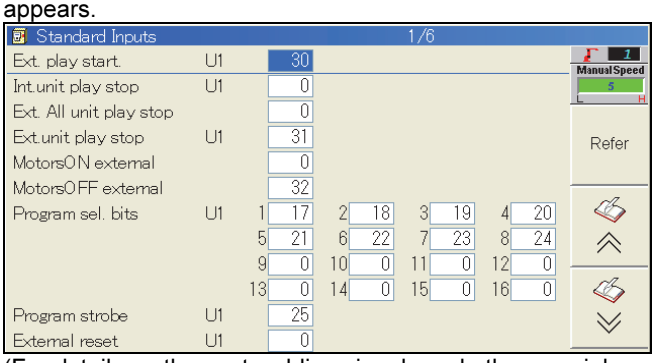


Fig. 4.6.1 Signal attributes

4.6.1 Standard signal attributes assignment

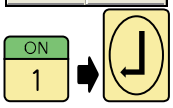
1 **Select the teach mode.**

2 **Select <Constant Setting> - [6 Signal attributes] - [2 Input signal assignment] - [1 Standard Inputs].**
>>The basic input signal assignment setting screen such as the one shown below now appears.



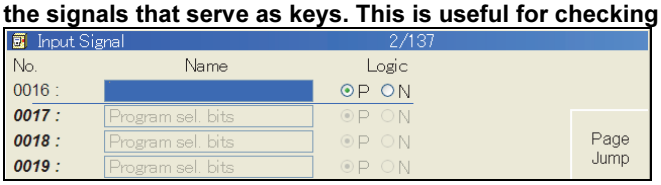
(For details on the spot welding signals and other special-purpose signals, refer to the operating instructions of the application concerned.)

3 **To switch the screen, press the page up or down key.**



4 **Align the cursor with the desired position, input the signal number (such as 1), and then press the [Enter] key.**
>>"Ext. play start [30]" means that signal no. 30 among the 2,048 logical input signals is treated as the start instruction. "Reduce speed [0]" signifies that this status signal is not used.

5 **When <Refer> key is pressed, the following table appears listing the numbers of the signals that serve as keys. This is useful for checking what has been set.**



A signal indicated in gray is a status signal; a signal indicated with black characters (or no characters) on a white background is a general-purpose signal.
After browsing, use the [RESET/R] key to exit.
Furthermore, it is possible to give names to the general-purpose signals on this screen. When the cursor is aligned, and the [ENABLE] + [EDIT] keys are pressed, the soft keyboard screen appears. Input the desired names on this screen.

6 **Upon completion of the settings, press <Complete> key. The settings are now saved in the constant file.**
>>It is not possible to assign a logical input signal to more than one status. When the <Complete> key is pressed, the assignment of all the logical input signals is checked, and if a signal has been assigned to more than one status, an error message is displayed. (This duplication check is conducted not only for the basic input signals but for all the input signals.)
>>After the signal assignment has been saved, operation returns to the input signal assignment menu.

7 **If the contents are not going to be rewritten, do not press <Complete> key but [RESET/R] key instead to exit the setting screen.**

8 **Similarly, basic output signals can be assigned in [6 Signal attributes] – [2 Output signal assignment] – [1 Standard Outputs].**
Operation is the same as for the basic input signals.

CAUTION

When the input signal or output signal assignment has been changed, turn off the power of the controller and then turn it back on.
This step must be taken without fail in order to initialize the status signals.
If operation is continued without turning off the power, the status signals may not be input or output properly.

4.6.2 Standard input signals

For details, refer to the following instruction manual.

"FD18/FD20 Controller Instruction Manual: EXTERNAL INPUT/ OUTPUT" (FD20-EN-007)

4.6.3 Standard output signals

For details, refer to the following instruction manual.

"FD18/FD20 Controller Instruction Manual: EXTERNAL INPUT/ OUTPUT" (FD20-EN-007)

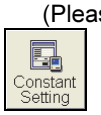
4.6.4 How to copy the I/O settings between the controllers

It is possible to copy the I/O settings between the controllers. (Import / export)
This function is convenient when it is necessary to use several controllers with a same setting.

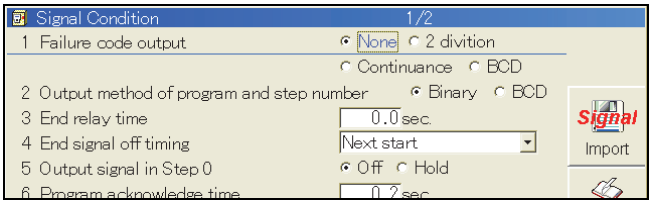
This operation should be performed after switching the operator class to ***EXPERT*** or higher.

Exporting the setting file

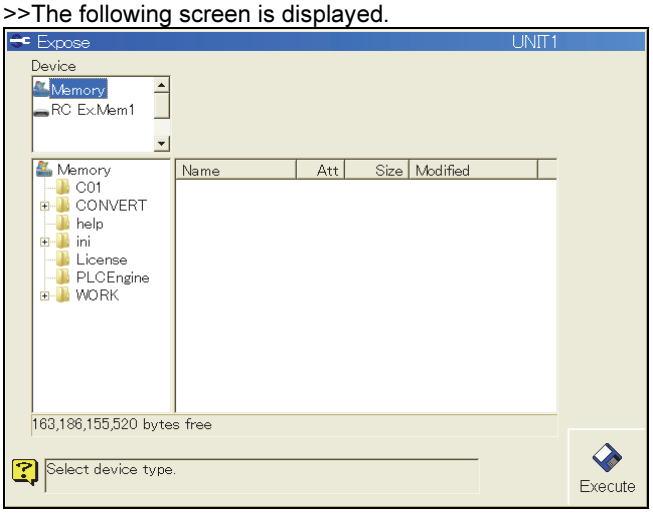
Let's export the I/O setting to the USB memory (RC Ex.Mem1).
(Please insert an USB memory to this robot controller in advance.)



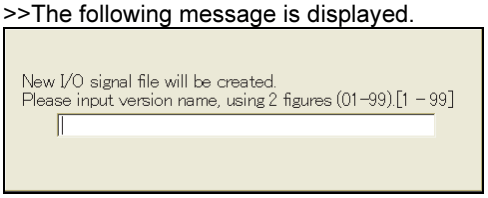
1 **Open <Constant settings> - [6 Signals] – [1 Signal Condition] menu.**

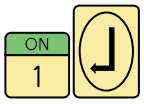


2 **Press [Enable] + [Export].**
>>The following screen is displayed.



3 **After selecting the destination folder for the export (In this case, "RC Ex.Mem1"), press <Execute>.**
>>The following message is displayed.



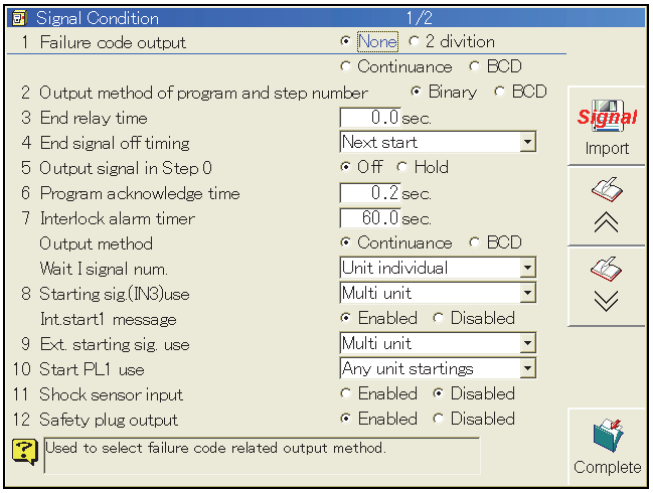


4 **Input the 2 digits (1-99) and press [Enter].**
>>A file with the following name will be created in the destination folder.
S**SIGL.CON ("**" is the inputted number)

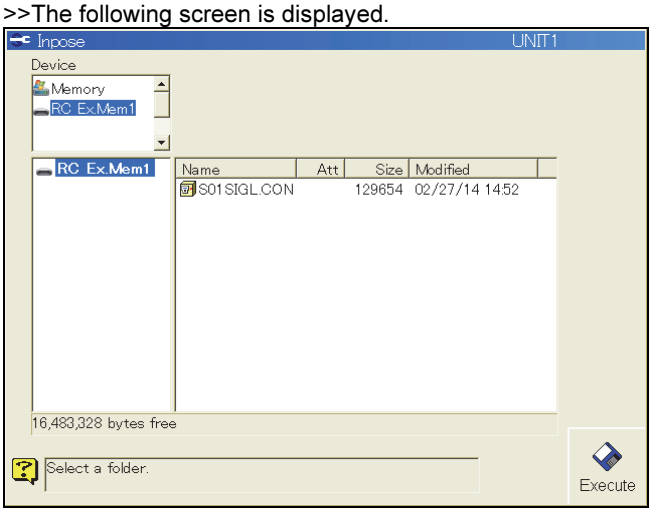
Importing the setting file

Let's import the I/O setting file that was exported to the USB memory in the previous section to the other controller.
(Please insert the USB memory to the robot controller in advance.)

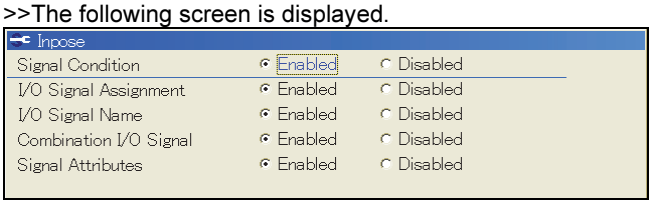
1 **Open <Constant settings> - [6 Signals] – [1 Signal Condition] menu.**

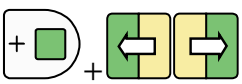


2 **Press <Import>.**
>>The following screen is displayed.



3 **Select the "S**SIGL.CON" in the USB memory (RC Ex. Mem1) using the [Cursor key] and the [Enter] key and then press <Execute>.**
>>The following screen is displayed.





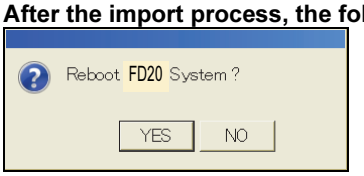
4 **Set *"Enabled"* for the field that you want to import.**

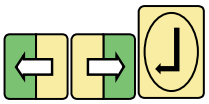
Signal condition	[SIG_COND]
I/O Signal Assignment	[IN_ASSIGN],[OUT_ASSIGN]
I/O Signal Name	[SIG_NAME]
Combination I/O Signal	[SIG_ASSIGN]
Signal Attribute	[SIG_ATTR]

For details of the respective fields, see the next section.

5 **After making the setting, press <Execute> to import.**
>>Only the selected fields will be imported from the *"S**SIGL.CON"*.

6 **After the import process, the following window will be displayed.**





7 **Select "YES" and press [Enter].**
>>The robot controller will restart, and then the settings will be available.

"S**SIGL.CON" is a plain text file.
Some fields can be imported but the other fields cannot be imported.

The fields that can be imported

[SIG_COND]

Description	Condition settings for various I/O signals
Setting menu	<Constant setting> - [6 Signals] - [1 Signal condition]

[IN_ASSIGN]

Description	The assignment setting for the input signals.
Setting menu	<Constant setting> - [6 Signals] – [2 Input Signal Assignment] [1 Standard Inputs] [2 Spot Inputs] [3 Arc Inputs] etc.

[OUT_ASSIGN]

Description	The assignment setting for the output signals.
Setting menu	<Constant setting> - [6 Signals] – [3 Output Signal Assignment] [1 Standard Outputs] [2 Spot Outputs] [3 Arc Outputs] etc.

[SIG_NAME]

Description	The names for the input signals and the output signals. Only *"SHIFT-JIS"* or *"ASCII CODE"* are available.
Setting menu	<Constant setting> - [6 Signals] – [7 Signal Attribute] [1 Input Signal] [2 Output Signal]
Example	IN1-16=**ABC**,,,,,,,,,,,,,,, The names for the input signals (I1 to I16). (I1 is "ABC") OUT1-16=**DEF**,,,,,,,,,,,,,,, The names for the output signals (O1 to O16). (O1 is "DEF")

[SIG_ASSIGN]

Description	The settings for the combination I/O signals.
Setting menu	<Constant Setting> - [6 Signals] [2 Input Signal Assignment] [7 Combination Inputs] Or <Constant Setting> - [6 Signals] [3 Output Signal Assignment] [7 Combination Outputs]
Example	MULTIIN_NAME_5101=ABC The multiple input signal of I5101 is set as "ABC". MULTIOUT_NAME_5101=DEF The multiple output signal of O5101 is set as "DEF".

[SIG_ATTR]

Description	The settings for the attribute of the I/O signals.
Setting menu	<Constant Setting> - [6 Signals] – [7 Signal Attribute] [1 Input Signal] [2 Output Signal] [3 Output Signal Attributes] [4 Pulse Table Setting] [5 Delay Table Setting]

The fields that cannot be imported

[SIG_HEADER]

Description	File header.

[UNITREADY_COND]

Description	The condition settings for the “Unit Ready Output Signal”.
Setting menu	<Constant Setting> - [6 Signals] - [4 Unit Ready Signal]

[OUTPUT_COND]

Description	Status output signal can be customized. Up to 16 settings can be registered.
Setting menu	<Constant Setting> - [6 Signals] - [5 State output customization]

[SIG_PORT]

Description	The connection relationship between the Logical signals and the Physical signals are set in this field. For details, refer to “4.8 I/O area mapping function”.
Setting menu	<Constant Setting> - [6 Signals] - [15 Hardware setting]

[SIG_MONI]

Description	Display items for the signal monitor window can be set.
Setting menu	<Constant Setting> - [6 Signals] - [17 Monitor setting]

[SIG_JW32]

Description	Not used.

4.7 Operator class (Operator Qualifications)

4.7.1 Operator class (Qualifications)

The operator class (qualifications) of individual operators can be set in this controller.
Once the qualifications of the individual operator are set, special functions or menus can be hidden from view or displayed depending on the expertise level of the operator who is operating the robot.
When, for instance, ***BEGINNER*** (beginner level operators) has been set as the operator qualifications, it is possible to place restrictions on the important menus and functions related to robot control so that the operator will not be able to operate them by mistake or out of carelessness.

Table 4.7.1 Operator class (qualifications)

Operator class	Operators targeted	Content
BEGINNER	Beginner level operators	This class is set for those operators who are beginning to learn about operating the robot and who only perform the startup of the robot in the factory.
USER	Regular operators	This class is set for those operators who are somewhat familiar with the operation of the robot.
EXPERT	Expert operators	This class is set for those operators who are in charge of maintaining the robot.
SPECIALIST	Senior expert operators	This class is set for a handful of the operators who are in charge of maintaining the robot.

Table 4.7.2 Restricted functions

Operator class / Main functions Whose access is restricted	***BEGINNER***	***USER***	***EXPERT***	***SPECIALIST***
General operations	○	○	○	○
Constants Setting	×	–	○	○
Functions and maintenance work requiring special expertise	×	×	○	○
Optional function settings	×	×	×	○

○:Can be accessed; ×:cannot be accessed; –: Partially not displayed.

4.7.2 Procedure for changing the operator class

When the control power is turned on, either ***USER*** or ***BEGINNER*** is set as the operator class. An operator of ***EXPERT*** or above can decide either one. page 4-64 "4.7.4How to set the operator class at power-on"
To change the operator class to ***EXPERT*** or above, use the short-cut code (R314) to make the switch each and every time it is required. Once the class of qualifications is switched, the new class is held until the operator qualifications class is switched again or the control power is turned off.

A password is required to change the operator class to ***EXPERT*** or above.
The initial passwords are listed below. The passwords can also be changed.
page 4-63 "4.7.3How to change the passwords"

Table 4.7.3 Initial password

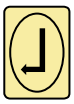
Operator class	Password set at the factory	Changing the password
BEGINNER	(No password provided)	(No password provided)
USER		
EXPERT	None (simply press [Enter])	Password can be changed (using short-cut code R313)
SPECIALIST	12345	

POINT

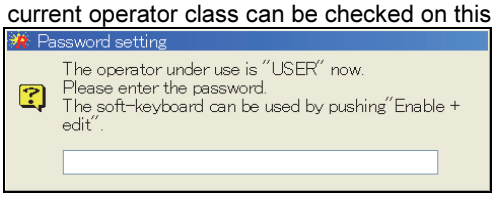
How the passwords work
* If the operator inputs the wrong password, ***BEGINNER*** or ***USER*** is set as the operator class.
* Since the initial passwords for ***EXPERT*** and ***SPECIALIST*** are given in these instructions and are open to anyone who reads the instructions, beginner level or regular operators can easily change their own operator class to the ***EXPERT*** or ***SPECIALIST***.
  Since there is a danger that the constants and other settings required to operate the robot may be changed in error by a beginner level or regular operator, the initial passwords must be changed as soon as the robot is delivered.

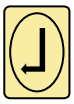
How to change the operator class

1 **Press [RESET/R].**
>>A table of the short-cut codes now appears.

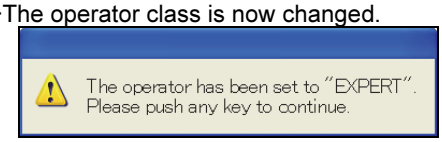
314 

2 **Input "314" using the numeric keys, and press [Enter].**
>>The password input screen now appears.
The current operator class can be checked on this screen.



Password 

3 **Input the password for ***EXPERT*** or ***SPECIALIST***, and press [Enter].**
If, for instance, the initial password is to be used and ***EXPERT*** is the operator class, press [Enter].
If ***SPECIALIST***, press "12345" followed by [Enter].
>>The operator class is now changed.



Operation returns to the original screen by pressing any key.

4.7.3 How to change the passwords

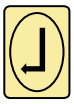
It is possible to change the passwords (for ***EXPERT*** and ***SPECIALIST***).
Alphanumerics (a distinction is made between upper case and lower case letters) and symbols are used as the characters which can be input for a password. All characters must be half-sized characters only. A password must not be more than 10 characters long.

CAUTION

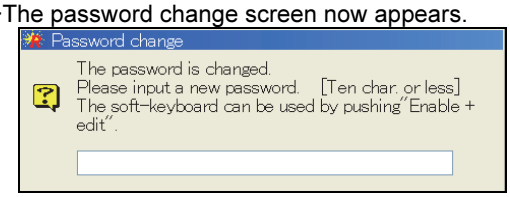
EXPERT or ***SPECIALIST*** operators must make a note of the new password which they have changed themselves without fail so that they will not forget it. If an operator has forgotten a password, the password cannot be set again insofar as he or she does not have a higher class of operator qualifications.

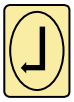
How to change the passwords

1 **Press [RESET/R].**
>>A table of the short-cut codes now appears.

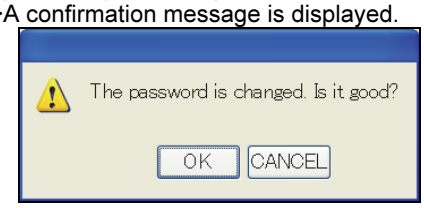
313 

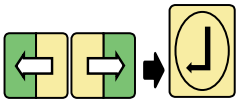
2 **Input "313" using the numeric keys, and press [Enter].**
>>The password change screen now appears.



Password 

3 **For a password that consists only of numerals, input the number using the numeric keys, and press [Enter].**
If letters or symbols are to be included in the password, input them from the soft keyboard by pressing [ENABLE] + [EDIT], and press [Enter].
>>A confirmation message is displayed.





4 **To make the change, select [OK], and press [Enter].**
>>The password is now changed, and operation returns to the original screen.

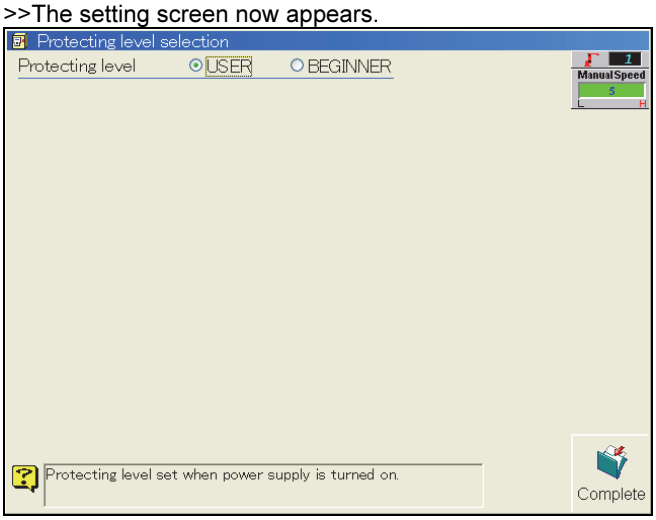
To cancel the change, select [CANCEL], and press [Enter].

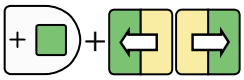
4.7.4 How to set the operator class at power-on

If the operator class is ***EXPERT*** or above, this class can be set to ***BEGINNER*** or ***USER*** when the control power is turned on. The operator class was set to ***USER*** at the factory.

How to set the operator qualifications class at power-on

1 **Select <Constant Setting> - [1 Control constants] - [8 Protecting level selection].**
>>The setting screen now appears.





2 **Select either *USER* or *BEGINNER*.**

3 **Press f12 <Complete> key.**
>>The setting is changed, and operation returns to the original screen.

4.8 I/O area mapping function

4.8.1 I/O area mapping

I/O area mapping function is the function to freely change logic input / output signals and allotment of physical media. By use of this function, it is possible to arrange I/O directly without software PLC. (PLC through input / output)
Mapping can be changed in unit of 8 points for I/O board signals, and in unit of 512 points for field bus signals.

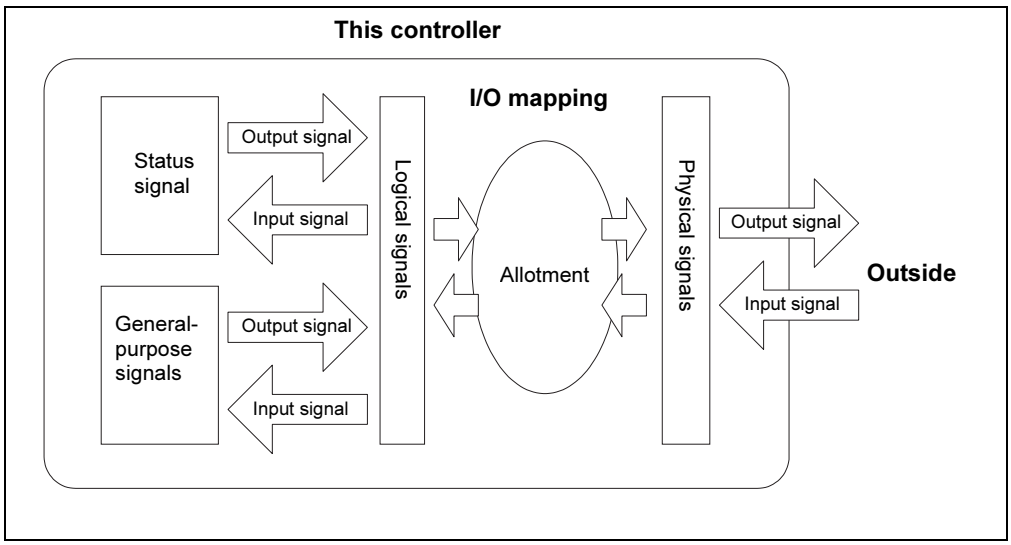


Fig. 4.8.1 Concept of I/O area mapping

At factory shipment, mapping is made as shown below. For example, the head signal output from the I/O board is fixed to 01 signal.

Table 4.8.1 Factory shipment setting of I/O area mapping

Physical port	Logic I/O signal
I/O board 1 (8 points x 4)	1 to 8 9 to 16 17 to 24 25 to 32
I/O board 2 (8 points x 4)	33 to 40 41 to 48 49 to 56 57 to 64
I/O board 3 (8 points x 4)	65 to 72 73 to 80 81 to 88 89 to 96
Mini I/O board (14 input, 10 output)	97 to 110
Field bus CH1 (512 points)	161 to 672
Field bus CH2 (512 points)	673 to 1184
Field bus CH3 (512 points)	1185 to 1696
Field bus CH4 (512 points)	1697 to 2208 (Actually, up to 2048)

By use of I/O area mapping function, change is made for example as shown below.

Table 4.8.2 I/O area mapping setting change example

Physical port	Logic I/O signal	
I/O board 1 (8 points x 4)	1 to 8 9 to 16 17 to 24 25 to 32	Same allotment as usual
I/O board 2 (8 points x 4)	-	No input / output with I/O board 2
I/O board 3 (8 points x 4)	-	No input / output with I/O board 3
Mini I/O board (14 input, 10 output)	-	No input / output with Mini I/O board
Field bus CH1 (512 points)	33 to 544	Field bus CH1 is used as signals of 33 to 544.
Field bus CH2 (512 points)	545 to 1056	Field bus CH2 is used as signals of 545 to 1056.
Field bus CH3 (512 points)	-	No input / output with field bus CH3.
Field bus CH4 (512 points)	1057 to 1568	Field bus CH4 is used as signals of 1057 to 1568.

By designating the number of logic signal to be allotted to the physical port, mapping is set. At that time, the number of logic signal is not written one by one, but it is designated by "port number" which is made into groups in prior in unit of 8 points.

Table 4.8.3 "Port number" used in I/O area mapping setting

Port	Logic I/O signal	Port	Logic I/O signal	Port	Logic I/O signal	Port	Logic I/O signal
1	1 - 8	***65***	513 - 520	***129***	1025 - 1032	***193***	1537 - 1544
2	9 - 16	***66***	521 - 528	***130***	1033 - 1040	***194***	1545 - 1552
3	17 - 24	***67***	529 - 536	***131***	1041 - 1048	***195***	1553 - 1560
4	25 - 32	***68***	537 - 544	***132***	1049 - 1056	***196***	1561 - 1568
5	33 - 40	***69***	545 - 552	***133***	1057 - 1064	***197***	1569 - 1576
6	41 - 48	***70***	553 – 560	***134***	1065 - 1072	***198***	1577 - 1584
7	49 - 56	***71***	561 - 568	***135***	1073 - 1080	***199***	1585 - 1592
8	57 - 64	***72***	569 - 576	***136***	1081 - 1088	***200***	1593 - 1600
9	65 - 72	***73***	577 - 584	***137***	1089 - 1096	***201***	1601 - 1608
10	73 - 80	***74***	585 - 592	***138***	1097 - 1104	***202***	1609 - 1616
11	81 - 88	***75***	593 - 600	***139***	1105 - 1112	***203***	1617 - 1624
12	89 - 96	***76***	601 - 608	***140***	1113 - 1120	***204***	1625 - 1632
13	97 - 104	***77***	609 - 616	***141***	1121 - 1128	***205***	1633 - 1640
14	105 - 112	***78***	617 - 624	***142***	1129 - 1136	***206***	1637 - 1648
15	113 - 120	***79***	625 - 632	***143***	1137 - 1144	***207***	1649 - 1656
16	121 - 128	***80***	633 - 640	***144***	1145 - 1152	***208***	1657 - 1664
17	129 - 136	***81***	637 - 648	***145***	1153 - 1160	***209***	1665 - 1672
18	137 - 144	***82***	649 - 656	***146***	1161 - 1168	***210***	1673 - 1680
19	145 - 152	***83***	657 - 664	***147***	1169 - 1176	***211***	1681 - 1688
20	153 - 160	***84***	665 - 672	***148***	1177 - 1184	***212***	1869 - 1696
21	161 - 168	***85***	673 - 680	***149***	1185 - 1192	***213***	1697 - 1704
22	169 - 176	***86***	681 - 688	***150***	1193 - 1200	***214***	1705 - 1712
23	177 - 184	***87***	869 - 696	***151***	1201 - 1208	***215***	1713 - 1720
24	185 - 192	***88***	697 - 704	***152***	1209 - 1216	***216***	1721 - 1728
25	193 - 200	***89***	705 - 712	***153***	1217 - 1224	***217***	1729 - 1736
26	201 - 208	***90***	713 - 720	***154***	1225 - 1232	***218***	1737 - 1744
27	209 - 216	***91***	721 - 728	***155***	1233 - 1240	***219***	1745 - 1752
28	217 - 224	***92***	729 - 736	***156***	1237 - 1248	***220***	1753 - 1760
29	225 - 232	***93***	737 - 744	***157***	1249 - 1256	***221***	1761 - 1768
30	233 - 240	***94***	745 - 752	***158***	1257 - 1264	***222***	1769 - 1776
31	237 - 248	***95***	753 - 760	***159***	1265 - 1272	***223***	1777 - 1784
32	249 - 256	***96***	761 - 768	***160***	1273 - 1280	***224***	1785 - 1792
33	257 - 264	***97***	769 - 776	***161***	1281 - 1288	***225***	1793 - 1800
34	265 - 272	***98***	777 - 784	***162***	1289 - 1296	***226***	1801 - 1808
35	273 - 280	***99***	785 - 792	***163***	1297 - 1304	***227***	1809 - 1816
36	281 - 288	***100***	793 - 800	***164***	1305 - 1312	***228***	1817 - 1824

Port	Logic I/O signal
37	289 - 296
38	297 - 304
39	305 - 312
40	313 - 320
41	321 - 328
42	329 - 336
43	337 - 344
44	345 - 352
45	353 - 360
46	361 - 368
47	369 - 376
48	377 - 384
49	385 - 392
50	393 - 400
51	401 - 408
52	409 - 416
53	417 - 424
54	425 - 432
55	433 - 440
56	437 - 448
57	449 - 456
58	457 - 464
59	465 - 472
60	473 - 480
61	481 - 488
62	489 - 496
63	497 - 504
64	505 - 512

Port	Logic I/O signal
101	801 - 808
102	809 - 816
103	817 - 824
104	825 - 832
105	833 - 840
106	837 - 848
107	849 - 856
108	857 - 864
109	865 - 872
110	873 - 880
111	881 - 888
112	889 - 896
113	897 - 904
114	905 - 912
115	913 - 920
116	921 - 928
117	929 - 936
118	937 - 944
119	945 - 952
120	953 - 960
121	961 - 968
122	969 - 976
123	977 - 984
124	985 - 992
125	993 - 1000
126	1001 - 1008
127	1009 - 1016
128	1017 - 1024

Port	Logic I/O signal
165	1313 - 1320
166	1321 - 1328
167	1329 - 1336
168	1337 - 1344
169	1345 - 1352
170	1353 - 1360
171	1361 - 1368
172	1369 - 1376
173	1377 - 1384
174	1385 - 1392
175	1393 - 1400
176	1401 - 1408
177	1409 - 1416
178	1417 - 1424
179	1425 - 1432
180	1433 - 1440
181	1437 - 1448
182	1449 - 1456
183	1457 - 1464
184	1465 - 1472
185	1473 - 1480
186	1481 - 1488
187	1489 - 1496
188	1497 - 1504
189	1505 - 1512
190	1513 - 1520
191	1521 - 1528
192	1529 - 1536

Port	Logic I/O signal
229	1825 - 1832
230	1833 - 1840
231	1837 - 1848
232	1849 - 1856
233	1857 - 1864
234	1865 - 1872
235	1873 - 1880
236	1881 - 1888
237	1889 - 1896
238	1897 - 1904
239	1905 - 1912
240	1913 - 1920
241	1921 - 1928
242	1929 - 1936
243	1937 - 1944
244	1945 - 1952
245	1953 - 1960
246	1961 - 1968
247	1969 - 1976
248	1977 - 1984
249	1985 - 1992
250	1993 - 2000
251	2001 - 2008
252	2009 - 2016
253	2017 - 2024
254	2025 - 2032
255	2033 - 2040
256	2041 - 2048

In the case when physical port is I/O board, mapping is made in unit of 8 points for logic input / output signal.

In the case when physical port is field bus (device net or the like), logic input / output signal is mapped in unit of 512 points. Namely, 64 ports (512 points) continuously are mapped from allotted port number as for field bus channel.

IMPORTANT

The mini I/O has an asymmetric signal point with 14 inputs and 10 outputs. Also, if you have a specific option or are using the feature, the number of signal points available will change. See Table 4.8.4 for details.

Table 4.8.4 I/O points of Mini I/I board and logical signal number

Option / Function	Input	Output	Input Logical No.	Output Logical No.
Operation panel (FD20-PANEL-A)	14	10	97-110	97-106
Operation box (Separate operation box) (FD20-OP64-C)	11	8	97-107	97-104
RMU Tool No. check function Monitor input setting	10	10	97-106	97-106

4.8.2 Relation with software PLC

When software PLC is used, I/O area mapping function does not work effectively. This is because the rudder program on software PLC executes I/O area mapping function. However, in mapping by software PLC, delay time occurs in ON/OFF of signal only for scan time of software PLC in principle.
Therefore, in this function, when software PLC is used, a function to change not all the areas but only designated area according to mapping information is prepared. This function is called "PLC through" herein. "PLC through" is the function to directly input / output (through) only designated area to physical port without influence of software PLC.

For example, in the case without "PLC through" function, even when to output an output O signal as an external signal as it is, it is necessary to write such a rudder program. But, by use of "PLC through" function, without writing such to PLC program, it is possible to output directly to the physical port, and PLC program can be simplified, and scan time can be shortened.

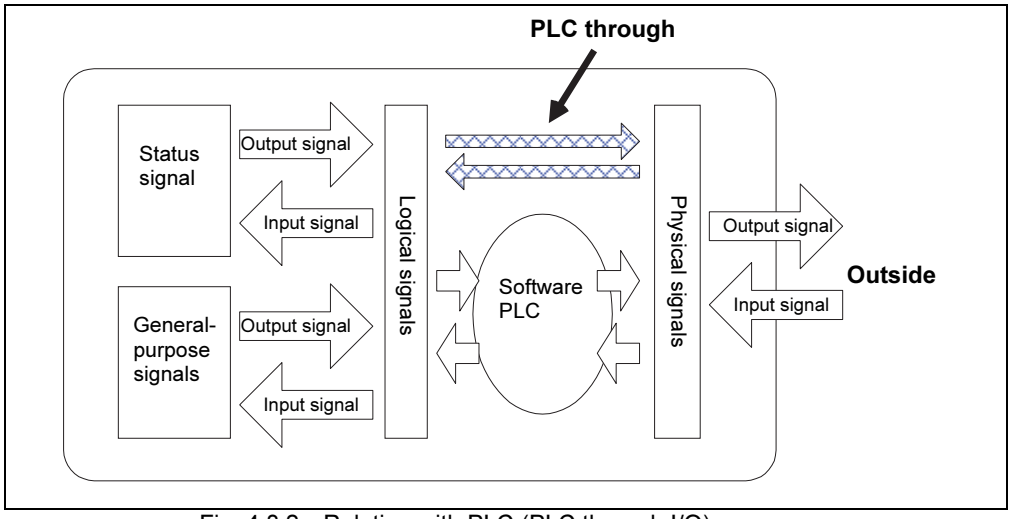


Fig. 4.8.2 Relation with PLC (PLC through I/O)

By the way, this function causes no influence upon software PLC itself, even if a rudder to be operated to signal of mapping change is written, it itself works normally. (However, actually, designated signals are input / output made directly with physical port.)

POINT

It becomes possible to apply for example, gripper controller use I/O signal can be connected to “Mini-I/O board” and apply software PLC program only to DeviceNet I/O at a same time by using this function.

(Example)

I1～I8 : Directly connect to “Mini-I/O board”（X0128～X0135）
O1～O8 : Directly connect to “Mini-I/O board”（Y0128～Y0135）
（Setting）
(1) Allocate port”1” （＝Logical signal 1～8）to ”Mini-I/O” board
(2) Place the check mark of ”input” and “output” of ”PLC through”

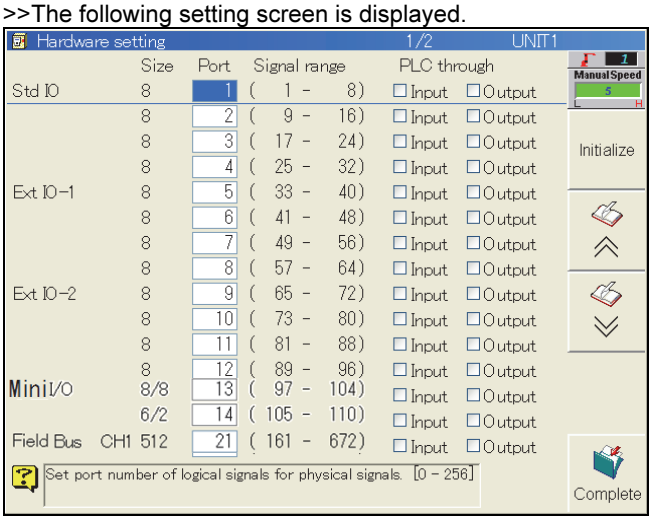
I9～I16 : Connect to DeviceNet through software PLC（X1000～X1007）
O9～O16 : Connect to DeviceNet through software PLC（Y1000～Y1007）
(Setting)
When the software PLC function is valid, settings except the port, which set “PLC through” of “Hardware setting” screen does not make sense when software PLC is valid. (However, software PLC has right to control,) it is recommended to set “0” at port.

4.8.3 Setting method

I/O area mapping setting is carried out in the following procedures.
Set the operator class to ***EXPERT*** or higher. (***USER*** or below can only browse setting contents.)

1 **Select the teach mode.**

2 **Select <Constant Setting> - [6 Signals] - [15 Hardware setting].**
>>The following setting screen is displayed.

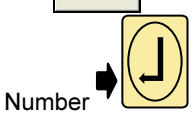


When mapping information is not written in "S00SIGL.CON" file, the above value is set as default setting.

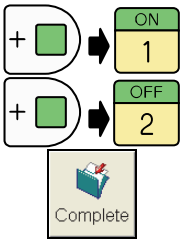
Meanings of display items are as shown below.

Parameter	Description
Number of points	This shows the number of signal points of each physical medium. 8 points x 4 for one I/O board. Field bus has 512 points of signals per channel.
Port	This designates the logic signal number of this controller by port number. For example, when "1" is designated by I/O board, the range of corresponding input signal is I1 to I8, and output signal is O1 to O8. When "12 is designated by field bus, the range of corresponding input signal is I1 to I512, and output signal is O1 to O512.
Signal number	The range of signal to input port number is automatically displayed.
PLC through	When "input" is checked, the signal concerned is forcibly input irrespective of the result of PLC program. In the same manner, when "output" is checked, the signal concerned is forcibly output irrespective of the result of PLC program. Data not checked is dependent on the action result of PLC program. On the contrary, at PLC cutoff, this setting makes no influence.

3 **Press f8 <initialize> key, and the setting contents go back to default ones (contents shown in 2).**



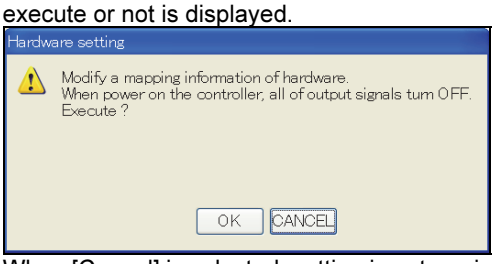
4 **Move the cursor to each logic port, and input numeric value of mapping information by port number.**
When "0" is input, no input / output with the physical medium.



5 **At PLC execution, when to directly input / output only specified area without via PLC, check the "PLC through " of the area.**
Move the cursor to desired " PLC through ", and press [Enable] and [1] at the same time to check it. By pressing [Enable] [2], it is unchecked.

6 **After completion of all the settings, press the f12 <Complete> key.**
>>The software checks whether there is duplication in the set area. If duplication is found, a popup message showing setting error is displayed. Press [Enter] and the cursor moves onto the place of duplication, so correct setting data.
In the same manner, even when all the ports are set as 0, a popup message showing setting error is displayed, so press [Enter] and carry out setting.

7 If there is contradiction in set data, a confirmation message whether to actually execute or not is displayed.



When [Cancel] is selected, setting is not carried out. (Not exit from this screen) Select [OK] and press [Enter], and the set data is written into "S00SIGL.CON" file, and you can exit this screen.

8 **According to the message, turn off the controller once and then turn it on again.**
You cannot exit the message unless turning the controller power OFF -> ON.

CAUTION

After changing mapping, according to the message, turn off the controller once and then turn it on again. This is necessary to initialize mapping information.

IMPORTANT

Once I/O mapping is changed, beware that all the output signals are cleared (OFF) after power restart.

IMPORTANT

As the result of setting, when signal number exceeds 2048, field bus signal is limited to 2048 unconditionally.
For example, the signal range in the case where "251" is designated to the logic port number of field bus is 2001 to 2048. (The number of signals is 48 points.)

IMPORTANT

As the number of signal points of field bus is 512 points, the logic port number of each channel must be away at least "64" or more. If not away, press <Complete> key, error message of area duplication is displayed, and setting cannot be made.

4.8.4 Example 1: Using only field bus as external I/O signals with PLC disconnected

For example, here are some mapping setting examples. (Shaded portions are items to be set.)

Even when only field bus is input / output with outside, normally 1888 points of 161 to 2048 are allotted to field bus signal.
When this is set as shown below, input / output signals of field bus are mapped to 1 to 2048, all the 2048 points can be used.

Table 4.8.5 Mapping example (making only field bus as external input / output signal with PLC disconnected)

Physical medium (number of signal points)		Port	Logic I/O signal number	PLC through Input	Output
I/O board 1	8	0	—	Ignored	Ignored
	8	0	—	Ignored	Ignored
	8	0	—	Ignored	Ignored
	8	0	—	Ignored	Ignored
I/O board 2	8	0	—	Ignored	Ignored
	8	0	—	Ignored	Ignored
	8	0	—	Ignored	Ignored
	8	0	—	Ignored	Ignored
I/O board 3	8	0	—	Ignored	Ignored
	8	0	—	Ignored	Ignored
	8	0	—	Ignored	Ignored
	8	0	—	Ignored	Ignored
Mini I/O board	8/8	0	—	Ignored	Ignored
	6/2	0	—	Ignored	Ignored
Field bus CH1	512	1	1 to 512	Ignored	Ignored
Field bus CH2	512	65	513 to 1024	Ignored	Ignored
Field bus CH3	512	129	1025 to 1536	Ignored	Ignored
Field bus CH4	512	193	1537 to 2048	Ignored	Ignored

In the case of PLC cutoff, check mark in PLC through process has no meaning.

4.8.5 Example 2: Using only I/O board 1 – field bus CH1 with PLC disconnected

When to use 32 points of I/O board 1 and 512 points of field bus channel 1 as continuous signals, make the setting as shown below.

Table 4.8.6 Mapping example (using only I/O board 1 - field bus CH1 with PLC disconnected)

Physical medium (number of signal points)		Port	Logic I/O signal number	PLC through	
				Input	Output
I/O board 1	8	1	1 to 8	Ignored	Ignored
	8	2	9 to 16	Ignored	Ignored
	8	3	17 to 24	Ignored	Ignored
	8	4	25 to 32	Ignored	Ignored
I/O board 2	8	0	—	Ignored	Ignored
	8	0	—	Ignored	Ignored
	8	0	—	Ignored	Ignored
	8	0	—	Ignored	Ignored
I/O board 3	8	0	—	Ignored	Ignored
	8	0	—	Ignored	Ignored
	8	0	—	Ignored	Ignored
	8	0	—	Ignored	Ignored
Mini I/O board	8/8	0	—	Ignored	Ignored
	6/2	0	—	Ignored	Ignored
Field bus CH1	512	5	33 to 544	Ignored	Ignored
Field bus CH2	512	0	—	Ignored	Ignored
Field bus CH3	512	0	—	Ignored	Ignored
Field bus CH4	512	0	—	Ignored	Ignored

4.8.6 Example 3: Enforcement of inputting / outputting signals of I/O board 1 as I1-I32 with PLC enabled

When to enforce input the input signals from I/O board 1 as I1 to I32, irrespective of PLC, and forcibly output O33 to O64 to I/O board 2, make the setting as shown below.

Table 4.8.7 Mapping example (enforcement of inputting / outputting signals of I/O board 1 as I1-I32 signals with PLC enabled)

Physical medium (number of signal points)		Port	Logic I/O signal number	PLC through Input	PLC through Output
I/O board 1	8	1	1 to 8	Checked	
	8	2	9 to 16	Checked	
	8	3	17 to 24	Checked	
	8	4	25 to 32	Checked	
I/O board 2	8	5	33 to 40		Checked
	8	6	41 to 48		Checked
	8	7	49 to 56		Checked
	8	8	57 to 64		Checked
I/O board 3	8	Ignored	?		
	8	Ignored	?		
	8	Ignored	?		
	8	Ignored	?		
Mini I/O board	8/8	0	—	Ignored	Ignored
	6/2	0	—	Ignored	Ignored
Field bus CH1	512	Ignored	?		
Field bus CH2	512	Ignored	?		
Field bus CH3	512	Ignored	?		
Field bus CH4	512	Ignored	?		

POINT

Even when mapping is changed by use of this function, there is no influence upon PLC relay number of physical medium. Even if the setting is made as shown above, for example, relay number of I/O board 2 remains X64 to X95 - Y64 to Y95.
And, their relay coil functions normally. (However, the status of coils Y64 to Y95 is not output to I/O board 2. Output is the status of O33 to O64.)

POINT

Only signals checked in PLC through process are enforced input / output.
Other signals are dependent on assembled PLC.

POINT

In the table, logic ports of items not related to forcible input / output are ignored, however, they must be set so that their signal area should not overlap.
At execution of PLC, logic port numbers of items not checked have no meaning, therefore, it is an effective method to input "0" expressly and avoid duplicated check of area.

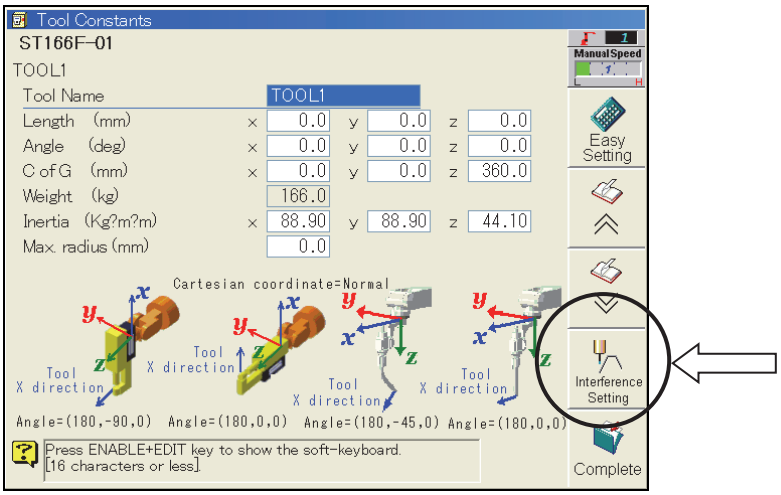
4.9 High Speed Interference Detection

4.9.1 Outline of High Speed Interference Detection

High speed interference detection function aims at protecting the tool by detecting and preventing collision of the tool and peripheral equipment. By utilizing this function, when miss-operation occurs during teaching work or some error occurs during playback, unexpected interference is detected to stop the robot immediately.

4.9.2 Applied machine types

A robot in which an "***Interference Setting***" f-key is displayed in <Constant Setting> - [3 Machine Constants] - [1 Tool Constants] screen can use this function. Normally, there are no data to be set at the setting screen that is displayed by pressing this f-key. Necessary parameters are set by system software automatically.



4.9.3 Parameters that must be set in advance to use this function

To use this function properly, the parameters listed below must be set properly in advance.

- COG (Center of gravity) [mm]
- Weight [kg]
- Inertia [kgm^2]

CAUTION

If these parameters are not set accurately, incorrect detection may occur (interference is not detected, or detected although interference never happens). Be sure to set the correct tool constants by referring to "4.5 Tool constant settings".

4.9.4 “Interference setting” screen

For this procedure, the operator class must be ***EXPERT*** or higher.

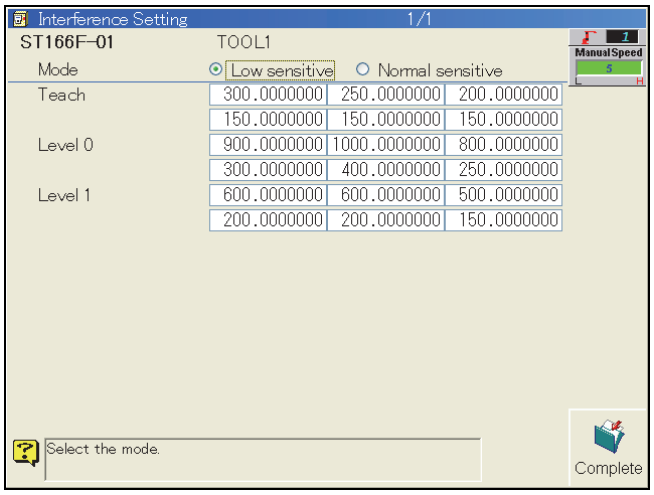


Table 4.9.1 Interference setting parameter

Item	Description
Mode	"Low sensitive" This is used when tool weight and C.O.G setting is not completed. The detection sensitivity is set moderately so as to prevent mistake in interference detection. "Normal sensitive" This is set when precise setting of tool weight and C.O.G. is completed. Detection recognition level is higher than that of “Low sensitive”. (Notes) After performing the automatic tool weight and C.O.G. setting procedure, this setting is automatically set to “Normal sensitive”. Not needed to change this setting manually.
Teach	This sets the detection level [kgfm] in teach mode when the mode is set to "Normal sensitive”.
Level 0	This sets the detection level [kgfm] in playback mode when the mode is set to "Normal sensitive".
Level 1	This sets high sensitivity detection level [kgfm] in playback mode when the mode is set to "Normal sensitive". This level becomes enabled when 1 is set to the argument of FN230 (interference detection level selection function). As for details, refer to the interference detection level selection function in the next section.

4.9.5 Switching Detection Level by Function

It is possible to switch the detection recognition level regarded as interference during playback.
For example, when inserting the end effecter into narrow space, interference is checked strictly by changing the detection recognition level lower. On the other hand, when carrying out the contact work, detection recognition level had better be changed to larger in order to prevent from mistake in interference detection.

For switching, "interference detection level selection function" is used. Details are as shown below.

Pneumonic	Number	Japanese name
COLSEL	FN230	Interference detection level selection function

Parameter

	Data	Contents, setting range
Parameter No.1	Level number (0 to 3)	This designates detection level number. 0: Normal use condition. The detection recognition level of level 0 is used (default). 1: This switches to specification condition at high sensitivity. The detection recognition level of level 1 is used. 2: This is designated when to get low sensitivity. The detection recognition level of low sensitivity at factory shipment is used. 3: This is designated when to disable interference function. This can be set only by ***EXPERT*** or higher

Unless this function is used, the detection recognition level set to level 0 is used always at playback.
At teaching, this function is carried out, but in the case of 0 and 1, all detection level of teach are used.
In the case when this function is executed, designated detection level is used until this function is executed for the next time.
Detection level automatically becomes 0 (level 0) at step 0 replay of program. However, in the case of program call, even in step 0, it does not automatically become 0 (level 0).
Even if it is stopped halfway and restarted, level is not switched. However, if step is selected, level automatically becomes 0, so when level is changed, use it with care.

4.9.6 As for the mistake in interference detection

Mistake in interference detection may happen in following cases.

No.	Situation
1	Tool constants such as C.O.G., weight and moment of inertia are much different from the actual values.
2	Plural axes move violently at the same time
3	Power supply voltage is low

If mistake in interference detection happens, check above situations at first. If everything is OK, try to change the detection recognition level or change to disabled by recording FN230(COLSEL) only around trouble steps.
Refer to “4.9.5 Switching Detection Level by Function” for FN230(COLSEL).

4.9.7 Trouble shooting

If interference is detected, please check the items listed below.

1. Check if the manipulator interferes with something or not.
2. Check if the tool settings (weight, C.O.G., inertia) match the actual load condition or not.
3. Lower the detection sensitivity level around the steps in which the interference is miss-detected or disable the detection function itself using FN230(COLSEL).
4. Check if the axis in which the error is detected has mechanical problems or not e.g. using brake release switch etc.
5. Check the wirings between the controller and the manipulator. (e.g. U,V,W phases current connection of the motor power, brake control lines, etc.)
6. Replace the unit (IPM drive unit) that includes brake power supply.

4.10 Setting the application type

In the <Constant Setting> - [12 Format and Configuration] - [7 Application] menus, you can enable various related functions, optimize the f key layout, and configure other settings in accordance with the application of the robot (application type). Although these settings are in most cases configured prior to shipment from the factory, they can be configured as necessary while referring to this section.

CAUTION

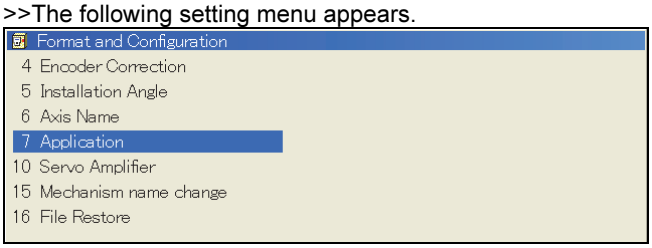
Only configure these settings once prior to the first time of use. Inadvertently changing them later may cause problems such as the initialization of various settings and the inability to use functions that were used up until that time.

Up to two application types per unit can be set. For example, if the robot can be used for both spot welding and handling, set "Usage1" to [Spot Welding] and "Usage2" to [Handling].

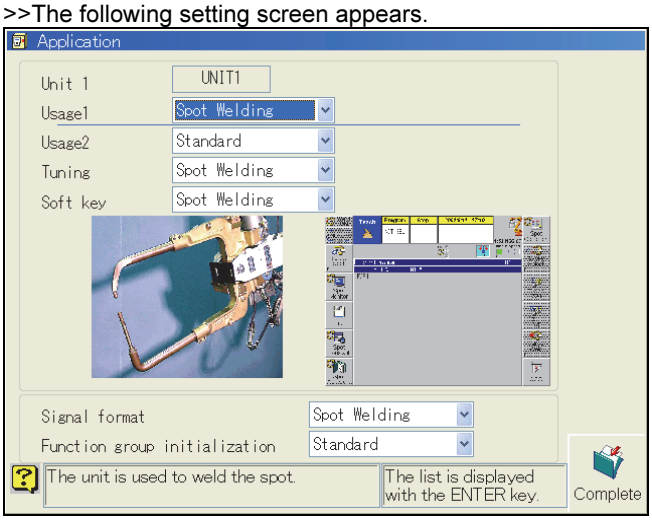
Configuration example

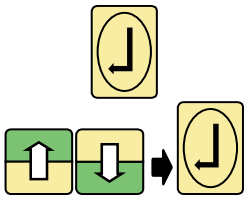
1 **First, input R314 and select operator class *EXPERT* or higher.**

2 **Select teach mode and <Constant Setting> - [12 Format and Configuration].**
>>The following setting menu appears.

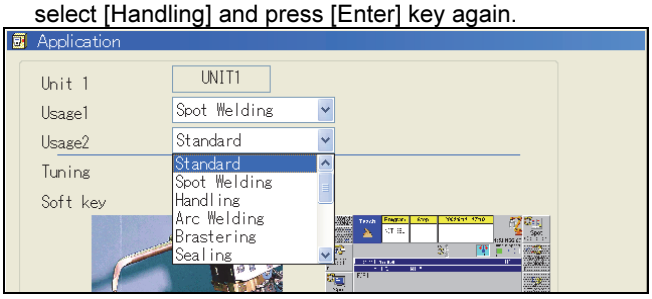


3 **Select [7 Application] from the menu.**
>>The following setting screen appears.





4 Align the cursor with "Usage1" or "Usage2", and press [Enter] key.
If, for example, the robot is also to be used for a spot welding application, select [Spot Welding] for "Usage1" and [Handling] for "Usage2".
>>A list of application selection candidates appears. Use the up or down cursor to select [Handling] and press [Enter] key again.



5 After completion of the settings, press the f12 <Complete> key.
The settings are written to the controller general constant file C00ctrl.con.
To stop configuring the settings, press the [RESET/R] key.

At present, the following application types can be selected.

Standard:	The standard functions are enabled.
Spot Welding:	For spot welding with a spot welding gun.
Handling:	For using the robot for a handling application. (This is necessary for Shift functions)
Sealing:	For sealing with a sealing gun.
Palletizeing	For palletizing functions.

Table 4.10.1 Items settable by unit

Item	Description
Usage1	Specify the application (usage) for the unit. The function commands (FN) and shortcuts that can be used vary depending the application that is set.
Usage2	Set this when one unit is to be used for multiple applications. Normally set this to [Standard].
Tuning	Specify the optimized control parameters to enable optimum control for the application. (Note that some mechanisms have no optimized parameters.)
Soft Key	Set the optimum soft key (f key) layout for the application type.

Table 4.10.2 Items common to all units

Item	Description
Signal Format	Initialize the input and output signals to a format suitable for the application.
Function group initialization	Initialize the function group to a format suitable for the application. (This item is currently unavailable).

4.11 Setting the [CLAMP / ARC] key

Any one of the following functions can be set for the [CLAMP/ARC] key of the hardware keys of the teach pendant.

(1) Function to turn specific output signals ON/OFF manually
(2) Spot welding function
(3) Arc welding function
(4) FLEX-HAND function

When the application is handling, an end effector such as a gripper is usually attached to the robot. This key can be used to open and close the gripper if the signal to open and close the gripper is assigned to function 1 above. Furthermore, this function is also compatible with grippers that use double solenoids because it is possible to assign two output signals and configure them to switch the gripper ON and OFF alternatively.

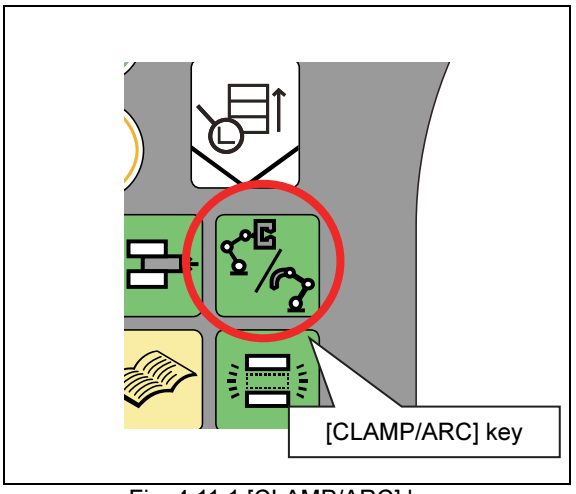


Fig. 4.11.1 [CLAMP/ARC] key of the teach pendant

The function of (1) and its usage are described hereinafter. As for (2), (3) and (4), please refer to the instruction manuals “APPLICATION MANUAL SPOTWELDING”, “APPLICATION MANUAL ARC WELDING” and “FLEX-HAND function”.

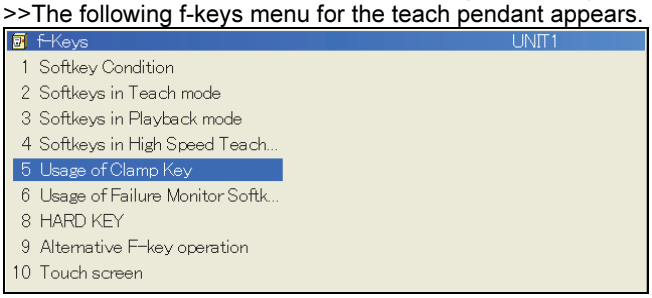
CAUTION

When the application is spot welding or arc welding, the [CLAMP/ARC] key is initially set for using the corresponding welding function and the key cannot be used to turn a signal ON/OFF manually.

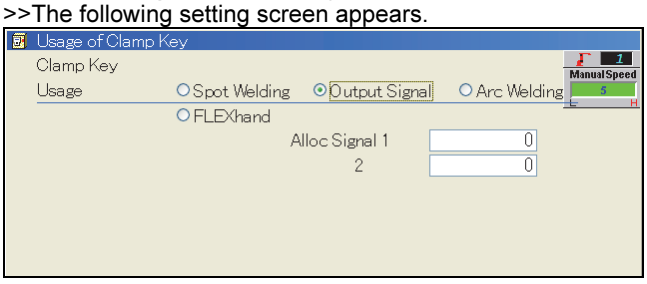
Setting Procedure

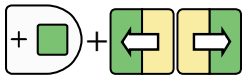
1 **First, input R314 and select operator class *EXPERT* or higher**

2 **Select teach mode and <Constant Setting> - [7 f-Keys].**
>>The following f-keys menu for the teach pendant appears.

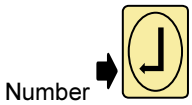


3 **Select [5 Usage of Clamp Key] from the menu.**
>>The following setting screen appears.





4 Align the cursor with "Clamp Key" and press the [ENABLE] and left or right cursor keys together to align the cursor to "Output Signal".



5 Next, align the cursor to "Alloc Signal," input the number of the output signal for opening and closing the gripper, and press [Enter] key.
Two output signals can be registered. If just one signal is to be used, set "1" only.
If two signals are to be used as is the case with double solenoids, set the two signals you want to use to switch ON and OFF alternatively for "1" and "2."

- The same signal cannot be input for both signal 1 and signal 2.
- When you want to set a multiple-output signal, set it for signal 1 only. Two multiple-output signals cannot be set.
- Signals that have already been assigned cannot be set.
- If 0 is set for the signal number, the key has no function.
- Even if the application differs depending on the unit, only one application can be set for the clamp key for safety reasons.

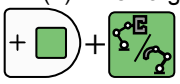
6 After completion of the settings, press the f12 <Complete> key.
The settings are written to the controller general constant file C00ctrl.con.
To stop configuring the settings, press the [RESET/R] key.

Using Clamp/Arc key (normal operation)

1 Just pressing the [CLAMP/ARC] key has no effect when the signal ON/OFF function has been set for the key. Furthermore, a function command cannot be registered.

Using Clamp/Arc key (with [ENABLE] key)

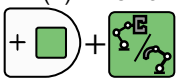
(1) When a general-purpose output signal is set



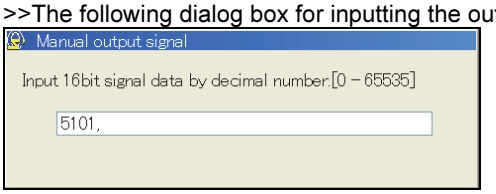
1 In teach mode, the set output signal can be turned ON/OFF manually.
Using the signal assigned to signal 1 of the clamp key output as the reference signal, output is performed by switching between ON and OFF alternatively.
The ON/OFF state of the output signal assigned to signal 2 is always the opposite to that of signal 1.

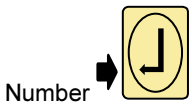
>>Pressing the [ENABLE] and [CLAMP/ARC] keys when signal 1 is OFF.
→Signal 1 is set to ON and signal 2 is set to OFF, regardless of the state of signal 2.
>>Pressing the [ENABLE] and [CLAMP/ARC] keys when signal 1 is ON.
→Signal 1 is set to OFF and signal 2 is set to ON, regardless of the state of signal 2.

(2) When a multiple-output signal is set



1 In teach mode, the set multiple-output signal can be output manually.
>>The following dialog box for inputting the output data appears.





2 Input decimal numbers for the data you want to output and press [Enter] key.

>>The registered output signal is turned ON/OFF in accordance with the specified numerical value.

4.12 Setting the software limit (operating range)

4.12.1 Outline

The software limit (operating range) is set to the maximum operating range prior to shipment from the factory. If the positions of the "stopper" and "limit switch" are changed or the operating area is changed for operational reasons, be sure to also change the software limit. There are the following three ways of setting the software limit. For these operations, an operator class ***EXPERT*** or higher is necessary.

(1) Position Recording

The robot is actually operated to move each of its axes to the position you want to set as the software limit and then the [REC] key is pressed. For the actual operation, refer to the following pages.

(2) Data Input

The software limit can be set without having to move the robot by inputting hexadecimals for the encoder values. Because of the nature of inputting numeric values and the difficulty of predicting the operating area, be extremely careful when configuring these settings. From "A" to "F" can be inputted via the following keys.

Table 4.12.1 How to input the hexadecimal values (A to F)

A	B	C	D	E	F
+ ON 1	+ OFF 2	+ 3	+ 4	+ 5	+ 6

POINT

This menu is convenient in case that software limit value of one robot is copied to that of another robot which is same type.
Software limit values (hexadecimals) to be input must be calculated beforehand.

(3) Auto Setting

The software limit range is calculated automatically from the posture data of programs registered in the internal memory of the controller and then set. Press <Select> key to select the programs from the list and then put the check marks for the axes to be used for the calculation. When the <Complete> key is pressed, the software limit (operating range) is automatically calculated. If it is necessary, set the margin parameters and then save the result with <Complete> key. When the software limit is set automatically, only the robot posture data included in programs is used to calculate the software limit. Therefore, an error may be generated if an interpolation operation results in the robot attempting a movement that exceeds the software limit. After setting the software limit automatically, confirm that all programs move the robot without a problem. Furthermore, if an error is generated, adjust the ±margin values.

DANGER

The software limit function is not for defining the limit area*. To change the limit area, use the "stopper" and "limit switch".
Unexpected robot motion leading to a person being hit or caught may result in loss of life, serious injury, or an accident.
* Limited area: The area the robot cannot move out of even if there is a failure or malfunction with the robot system.

WARNING

When software limit is changed, please do not forget to confirm that robot surely stops at the defined software limit by manual operation. If this procedure is omitted, wrong setting by mistaking operation may result in death, serious injury, or an accident.

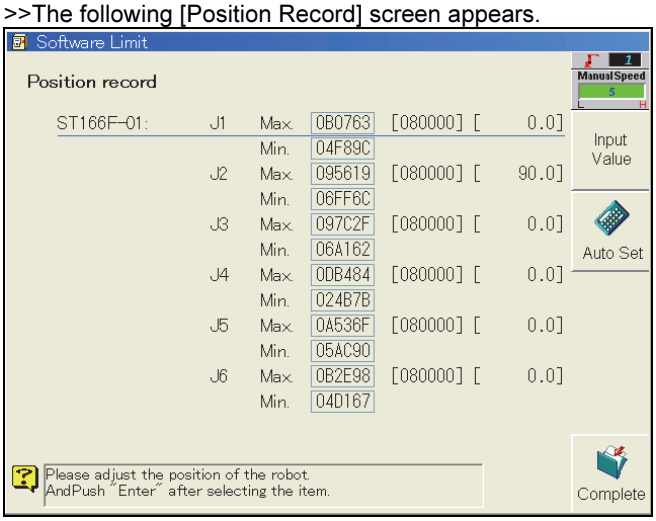
CAUTION

The following items are **not supported** for auto setting of the software limit.
(1) Servo gun axis*(The checkmark cannot be turned ON)
(2) Endless axis*(The checkmark cannot be turned ON)
(3) Other than angle commands of robotic language for each axis angle (MOVE/ MOVEJ/MOVEX_J/MOVEX_E)
* Calculation is not performed automatically, but values can be input directly in the data input area.

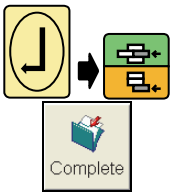
4.12.2 [Position record] screen settings

Operate the robot to move each of its axes manually and set the software limit values.
The operator class needs to be ***EXPERT*** for this operation.

1 **Select <Constant Setting> - [3 Machine Constant] - [5 Software Limit] and press <Record Posi.>**
>>The following [Position Record] screen appears.



2 **Align the cursor with the target axis and operate the robot manually to move each axis to a position you want to set for the software limit.**



3 **Press [Enter] key and then press [REC] key.**
>>The software limit values are overwritten.

4 **Press the <Complete> key.**
>> The software limit values are registered and the [3 Machine Constant] menu reappears.

By moving robot, check the relationship between the rotating direction and the increase/decrease of encoder data without fail. If “max” value and “min” value is set opposite by mistake, robot can never move. In this case, please modify these values by utilizing [Input Value] menu.

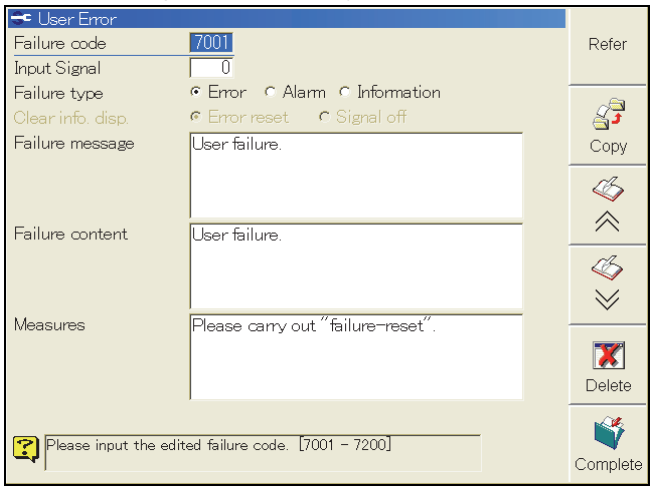
4.13 User defined error

It is possible to define an error message and this error can be displayed on the teach pendant screen using input signal. The content of the message can be edited.

Setting procedure

1 **Open <Service Utilities> - [25 Robot Diagnosis] [6 User Error].**

>>The following screen is displayed.



Edit the existing user error.

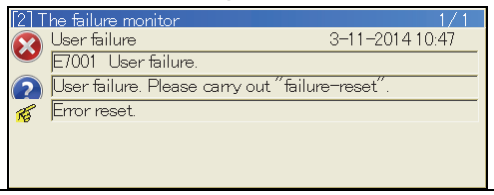
Copy the content of the current user error to the other error number.

Delete (initialize) the current user error.

2 **After setting the respective items, press <Complete>.**

>>The settings are saved to the internal memory.

3 **When the "Input Signal" is turned ON, the error window is displayed.**



Item	Description	
Failure code	Set the error number. (7001 to 7200)	
Input Signal	This is the trigger signal (input signal) to display the error. (0 to 2048)	
Failure Type	Select the type of the error (Error / Alarm / Information) For details, refer to the following manual. ***"CONTROL AND MAINTENANCE FUNCTION" Chapter 4***	
Clear info. disp.	Set the way to delete the "information" display. This setting can be changed only in case of "Information" is selected at "Failure Type".	
	Error reset	The information display can be turned OFF in case of "error rest", "motors ON", "program start", or "teach pendant operation", etc. The information display is not turned OFF when input signals are turned OFF.
	Signal off	The "error reset", "motors ON", "program start", or "teach pendant operation" cannot turn OFF the information display. When the input signal turns OFF, the display of the information will turn OFF.
 Failure message	Input the error message Character input screen is displayed by [Enable] + [Edit].	
 Failure content	Input the error content. Character input screen is displayed by [Enable] + [Edit].	
 Measures	Input the measures. Character input screen is displayed by [Enable] + [Edit].	

4.14 User coordinate system

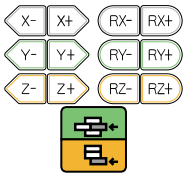
If a ***"User coordinate system"*** is defined in advance, the teaching operation may become easier in some cases. (E.g. in a case in which the work-table installation direction is not parallel with the machine (robot) coordinate system)

POINT

- To define a user coordinate system, a program that has 3 MOVE commands is necessary.
- Please make an accurate setting of a TOOL (especially, TCP position) in advance.
- To create a user coordinate system with accurate direction, it is recommended to use the edge points of the table. (The distance between each point should be as far as possible)
- User coordinate system can be defined up to 100.
- It is possible to create movement command at cartesian coordinate system of user coordinates standard by using "FN645 MOVEX".

4.14.1 Setting example

How to define a user coordinate system using a teaching program



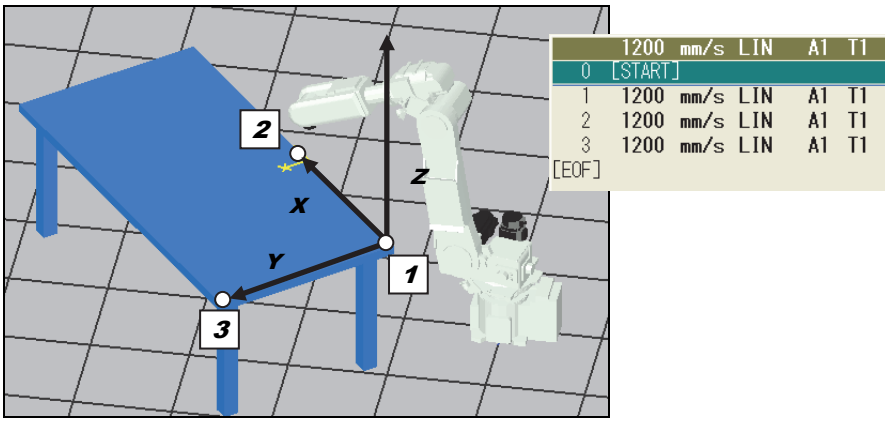
1 **First, please create a program that has 3 MOVE commands to define a user coordinate system. In this example, 3 steps are recorded in the Program No.1.**

1 : The origin(reference point) of the user coordinate system

2 : A point that determine the X axis direction

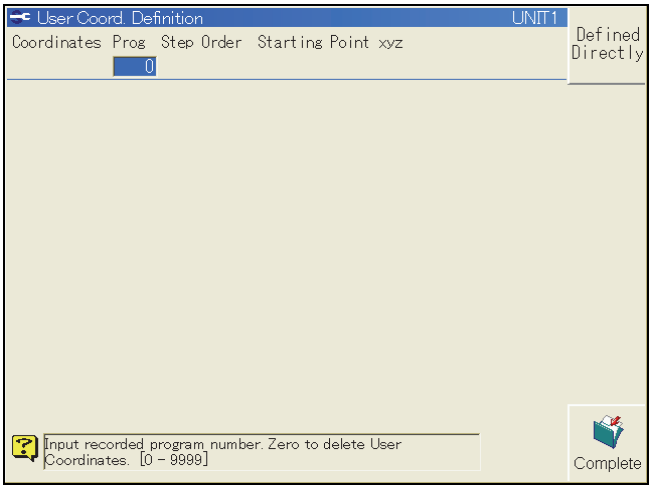
3 : A point that determine the Y axis direction

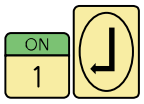
(The direction of the Z axis is automatically calculated.)



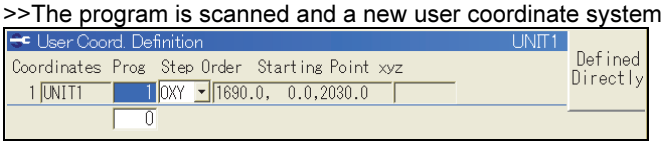
2 **Open <Service Utilities> - [10 User Coord. Definition].**

>>The following screen will be displayed.





3 **Enter the number of the program created in the procedure 1 (=”1”) and press [Enter].**
>>The program is scanned and a new user coordinate system 1 is defined.



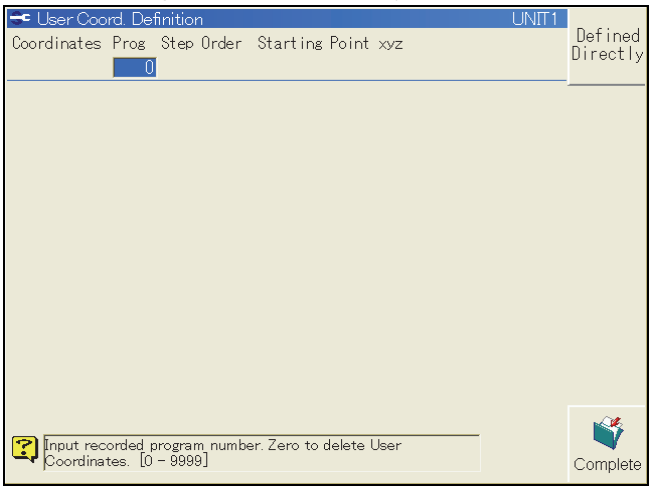
“Step Order”
OXY : Origin, a point to determine the X direction, a point to determine the Y direction
OZX : Origin, a point to determine the Z direction, a point to determine the X direction
OYZ : Origin, a point to determine the Y direction, a point to determine the Z direction

4 **Press <Complete>**
>>The defined user coordinate system 1 is saved in the internal memory.

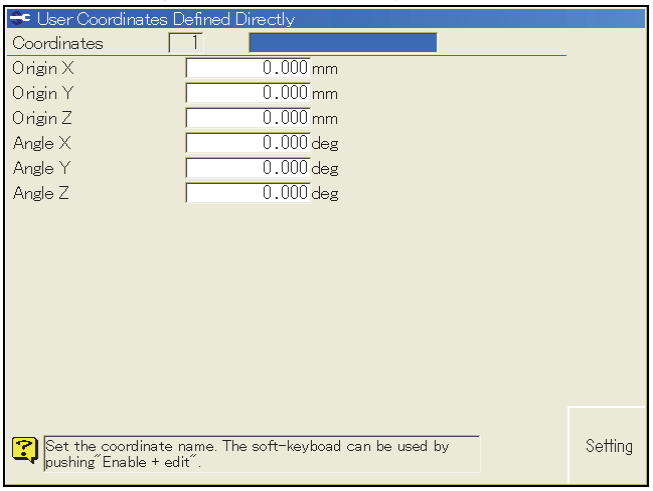
5 **Press [R] key several times to exit from the setting menu.**

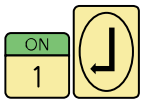
How to define a user coordinate system by direct input (FDV04.05 or after)

1 **Open <Service Utilities> [10 User Coord. Definition>**
>>The following screen will be displayed.

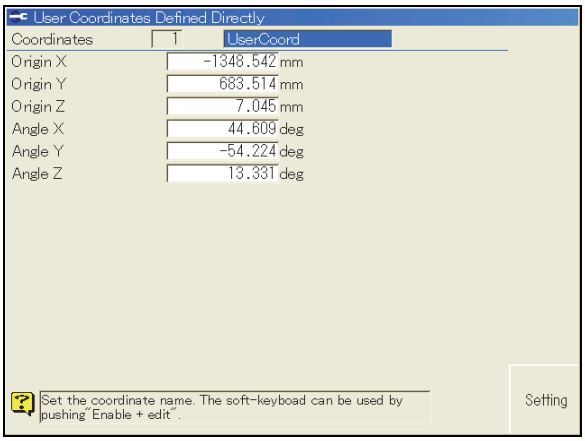


2 **Press <Defined Directly”**
>>The following screen will be displayed.



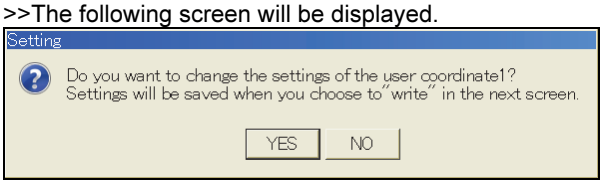


3 **Input the origin and the direction.**



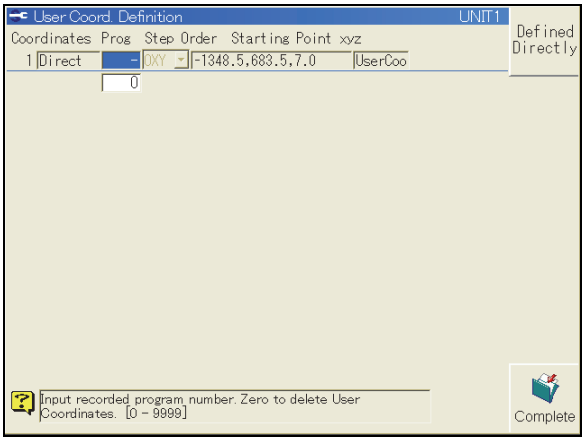
4 **Press <Setting> key.**

>>The following screen will be displayed.



5 **Select "YES".**

>>The "User Coord Definition" screen is displayed again. "Direct" is shown on the line.



(Be sure that the user coordinate system has not been saved yet in this screen.)

6 **Press <Complete>**

>>The defined user coordinate system 1 is saved in the internal memory.

Item	Description
Coordinates	Input the name of the coordinate system. The name that is set here is displayed in the screen of “User Coord. Definition”.
Origin	Input the position of the origin of the user coordinate system. The XYZ values should be set based on the world coordinate system. If the “Base coordinate” is designated, these coordinates show the origin of the user coordinate system based on the designated user coordinate system.
Angle	Input the rotational angle of the user coordinate system. The angle values should be set based on the world coordinate system. The angle of the user coordinate system is determined by the rotation of the world coordinate system in the order of Z,Y, and X. If the “Base coordinate” is designated, these angles are the rotational angles around the designated coordinate system.
Base coordinate	This is the reference coordinate system. If 0 is set, the world coordinate system is used.

An example of User Coordinate system registration

To create a User coordinate system like the following figure (left side), input the parameters like the following picture (right side).

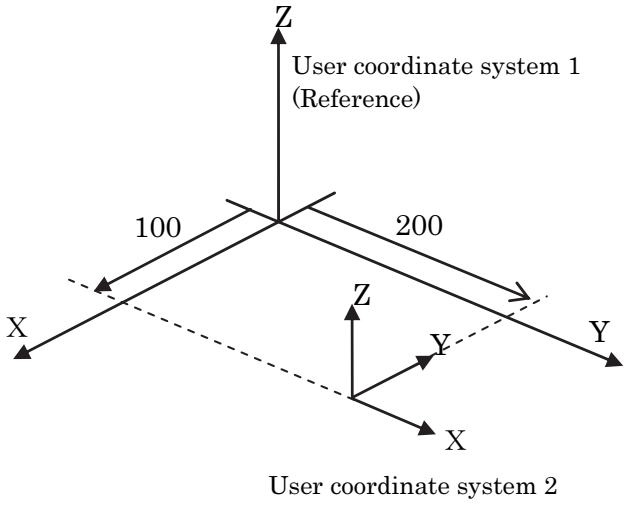


Fig.4.14.1 An user coordinate system

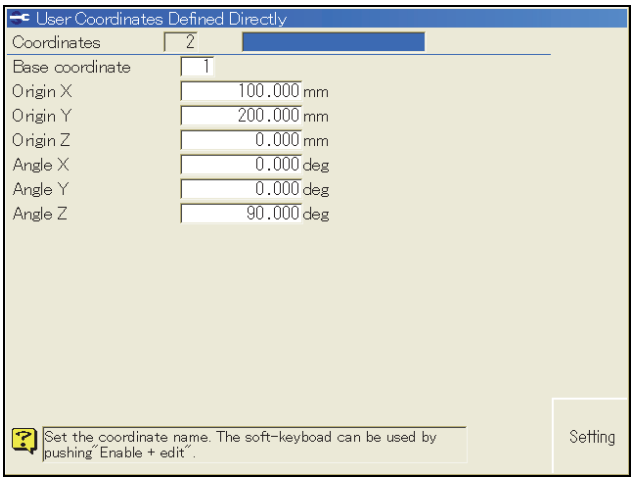
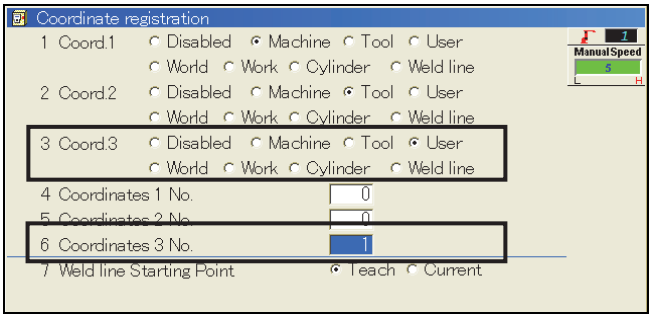
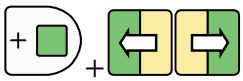


Fig. 4.14.2 Setting for this user coordinate system

Register the user coordinate system to the manual operation coordinate system

1 **Open <Constant Setting> - [5 Operation Constants] - [5 Coordinate registration]**
>>The following screen is displayed.

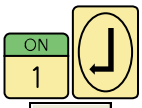




2 **Change the setting like the followings;**

"3 Coord.3" = "User"

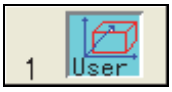
"6 Coordinates 3 No." = "1" (The No. of the defined user coordinate system)

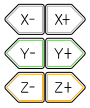


3 **Press <Complete>**
>>The setting is saved in the internal memory.

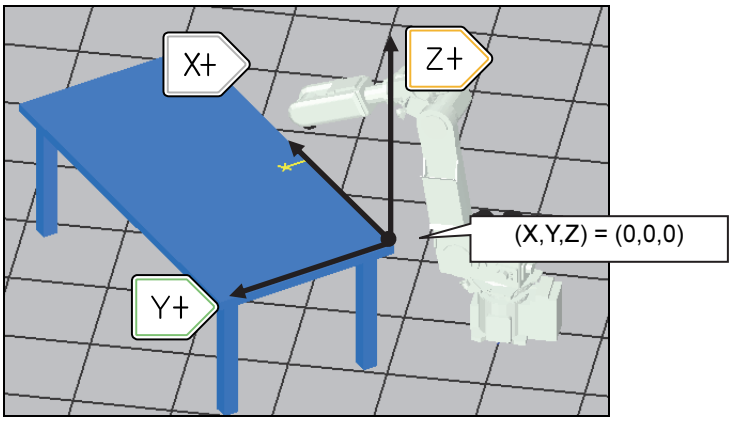
4 **Press [R] key several times to exit from the menu screen.**

5 **Press [INTERP/COORD] key several times.**
>>"User coordinate system" icon will show up on the screen. The number shows the user coordinate system number currently being used.





6 **Try to move the robot using the axis operation keys.**
>>The robot moves along the user coordinate system.



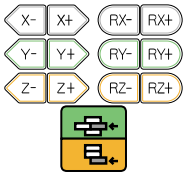
4.14.2 Stationary tool

A tool that is fixed on the floor is called as ***"Stationary tool"***. (e.g. stationary sealing gun, etc.) And the TCP and the direction of the stationary tool can be defined by using the user coordinate system.

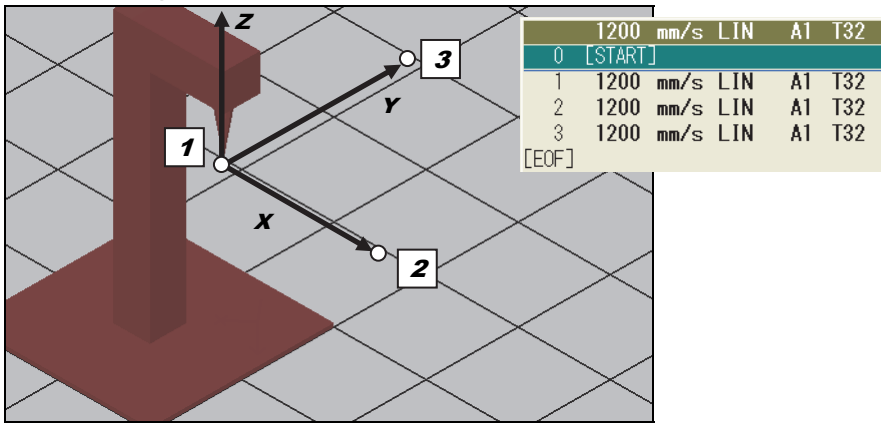
POINT

- In case of an application that requires the path accuracy, please prepare an accurate tool constant when defining the user coordinate system. (For example, please use a sharp wire or a pin fixed on the robot hand.) And, because this tool constant is used only for defining the user coordinate system, the constant should be set to TOOL32 for example.)
- In case of a stationary spot welding gun (pedestal gun), the user coordinate system is not used. But the press direction (direction of the Z axis) of the welding gun mechanism must be set in the following menu.
  <Constant Setting> - [12 Format and Configuration] - [5 Installation Angle]
- For details about the stationary welding gun, refer to the following instruction manual.
  "FD CONTROLLER INSTRUCTION MANUAL / For Expert operators SERVO GUN ADJUSTMENT PROCEDURE" Section 1.9.5 "Installation Position Setting"

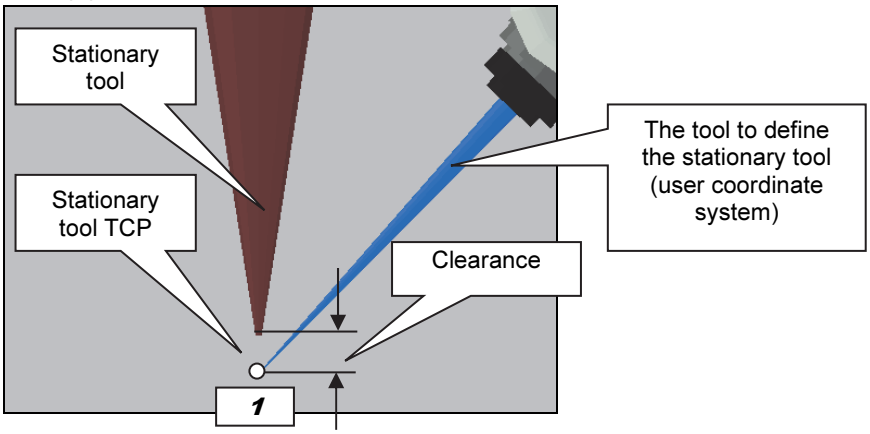
How to define a user coordinate system for a stationary tool



1 **Move the robot tool tip to the position of the stationary tool tip, and record the position as the origin (reference point 1). And then record other 2 points referring to the following picture.**



(NOTE)
In case of a sealing gun, please use the point shown in the following picture as the origin. This "Clearance" is the distance between the stationary tool tip (nozzle of the sealing gun) and the surface of the work-piece.



(Figure) Point the origin of the stationary coordinate system's origin using the robot tool tip (TCP).

2 **Define a user coordinate system using this program. (See "4.14.1Setting example")**

>>Via the operations in the following pages, this user coordinate system can be used as a ***"Stationary tool coordinate system"***.

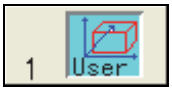
How to operate the robot based on the stationary tool interpolation

When the following 2 conditions are satisfied, the robot can be operated manually based on the stationary tool.

1: ***"User coordinate system"*** is selected as the manual operation coordinate system.

2: <Service Utilities> - [1 Teach / Play Condition] [12 Interpolation origin] is set to ***"Stationary"***.

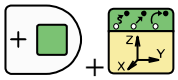
1 **Select the user coordinate system (=Stationary tool) for the manual operation.**

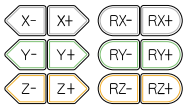


2 **Open <Teach / Play Condition> screen and set the "Interpolation origin" to "Stationary".**

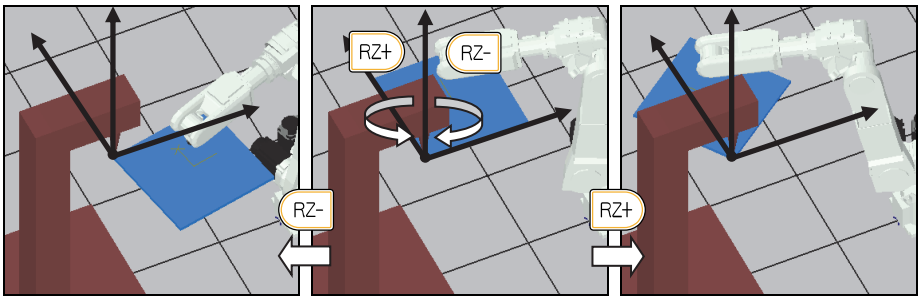
>>The interpolation type in the recording status bar will change to ***"S-LIN"***

If *"S-LIN"* is not displayed, please press [Enable] + [INTERP/COORD].





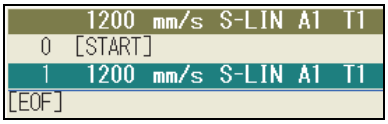
3 **When moving the robot with manual operation, the robot moves based on the stationary tool. For example, the robot will rotate around the Z axis of the stationary tool when pressing the [RZ-][RZ+] keys.**



(Supplement)

When other coordinate system is selected, the stationary tool interpolation in the manual axis operation is disabled temporary.

4 **If [REC] key is pressed, a MOVE command with "S-LIN" interpolation will be recorded in the program.**



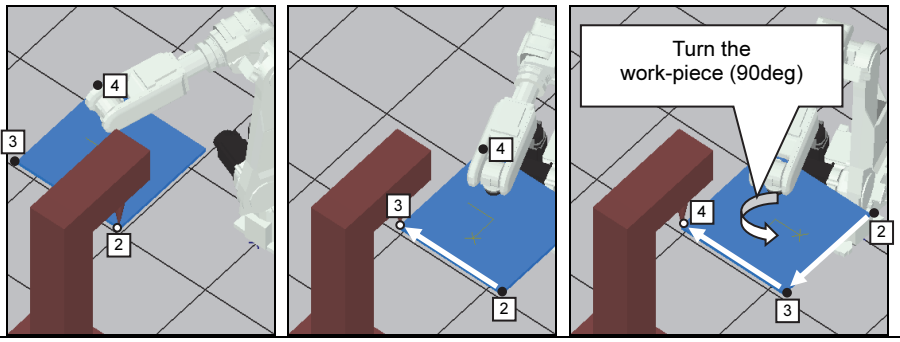
But, to execute a stationary tool interpolation while playing back a program, it is necessary to select the user coordinate system that is used as a stationary tool in advance. For this, please use ***"FN67 STOOL"***. (See the next page)

An example of a program to use a stationary tool

```
0  [START]
1  STOOL[2]
2    300 mm/s LIN    A1  T1
3    300 mm/s S-LIN  A1  T1
4    300 mm/s S-LIN  A1  T1
5  END
```

1 **First, execute *"FN67 STOOL"* to select the user coordinate system for the stationary tool interpolation.**

2 **Step 2, 3, and 4 should be recorded like the following pictures.**



3 **The interpolation type for the step3 and the Step4 should be set to "S-LIN".**

Method 1

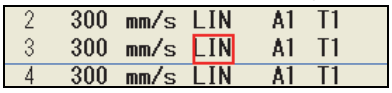
(1) Open <Teach / Play Condition> screen and set the "Interpolation origin" to "Stationary".

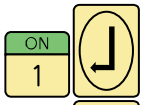
(2) The interpolation type in the recording status bar will change to ***"S-LIN"***

(3) When pressing the [REC] key, a step of interpolation type ***"S-LIN"*** will be recorded.

Method 2

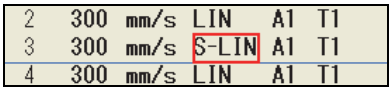
(1) After recording a MOVE command, open the edit screen and place the cursor to the position of interpolation type of the step.

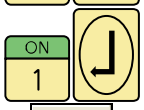




(2) Press [1], [Enter], [1], [Enter] sequentially.

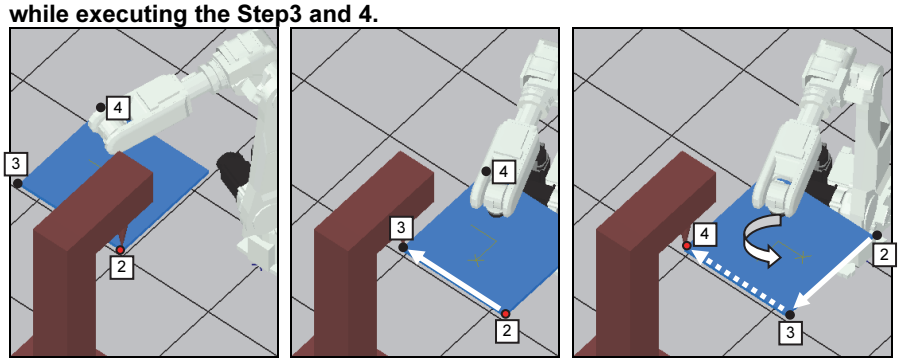
(3) ***"S-LIN"*** is set like this picture.





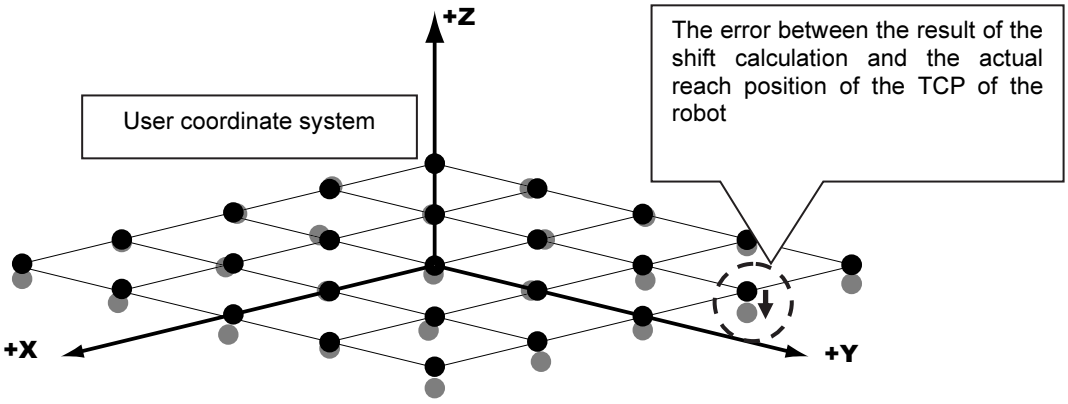
(4) After setting "S-LIN" for the desired steps, press <Complete> to save.

4 **When performing CHECK GO operation from the step0, the robot will be controlled so that the stationary tool's tip will go along the edge of the work-piece while executing the Step3 and 4.**



4.14.3 User coordinate system compensation

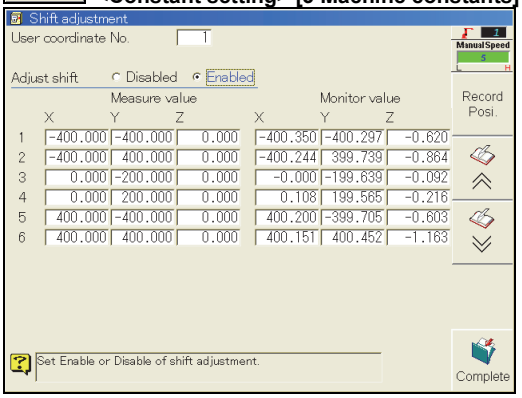
For example, when executing "FN52 Shift" on the User coordinate system that is defined on the Work-piece, there may arise small position error at the position where the actual robot's TCP reaches.



(Example) The difference between the calculated position and the actual reach position
(● : Teach point given by the shift calculation / ● : The position where the actual robot TCP reaches)

By using the following menu, it is possible to lighten the position error like this.
(To use this function, the operator class ***EXPERT*** or higher is required.)

<Constant setting> [3 Machine constants] [39 Shift adjustment]



POINT

- The absolute position accuracy of a robot is affected by various elements. (e.g. (1)rigidity of the tool or the robot itself, (2)setting accuracy of the TCP(tool center point), (3)positioning accuracy of the work-piece, (4)installation accuracy of the robot etc.) Because this function is based on a simple compensation logic that uses approximate comparison calculation using actual TCP position and the calculated coordinates on the user coordinate system, it is possible to lighten the position error but the accuracy is not guaranteed.

- This function works only in the area surrounded by the sampling points that are set in the setting screen.

- This function cannot cover the all motion range of the robot.

- If the robot or the work-piece is large, there is a possibility that the enough compensation result cannot be acquired.

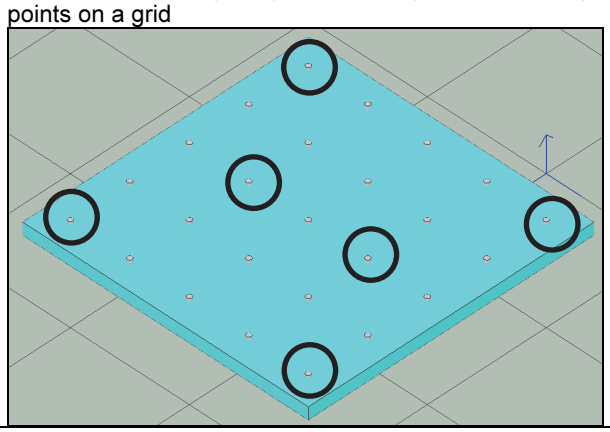
- This function is affected by the setting accuracy of the TCP. Please set the TCP accurately as much as possible.

- The encoder correction (= encoder offset setting of each axis) must be done accurately by following correct procedure in advance. If the encoder correction value is inaccurate, the position error of the posture calculation of the robot becomes large and the compensation results will be affected by the error.

- When the mechanical elements (e.g. robot itself, servo motor, tool, work-table, etc.) are replaced, this function must be checked or set again. (Not only this function, the tool constants must be adjusted again)

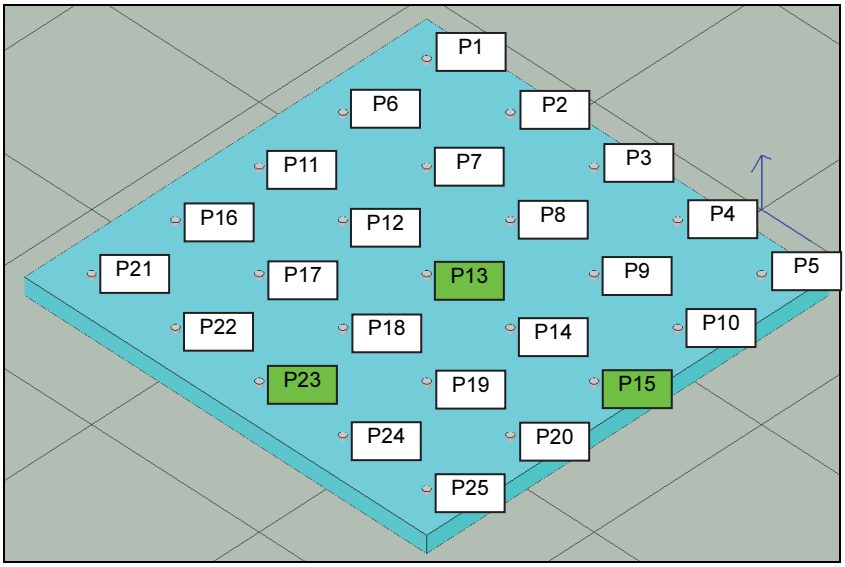
Setting item

Please prepare ***"(1)XYZ coordinates of the sampling points (6 at maximum, 4 at minimum)"*** and ***"(2)XYZ coordinates that are displayed on the teach pendant screen when moving the robot to the position of (1)"*** for every user coordinate system. Based on these data, the location and the angle of the concerned user coordinate system will be compensated.

Name	Range	Description
User coordinate No.	1 to 100	This is the User coordinate system to be compensated by this function.
Adjust shift	Disabled / Enabled	Enable / Disable setting of this compensation function.
Measure value 1 to 6 X, Y, Z	-9999.999 to 9999.999	This item is the ***"XYZ coordinates of the sampling points"***. Based on the following standards, choose the sampling points (6 at maximum, 4 at minimum). The coordinates must be inputted based on the concerned user coordinate system. **<Check points>** - It is better to use the edge point of the work-piece - The teach points used in the application program should be surround by the sampling points - The sampling points should be dispersed over a wide range. - It is possible to refer to the coordinates shown on the design drawing. But, it is better to use the measured coordinates using the actual work-piece. (Example) When getting 6 sampling points among the points on a grid 
Monitor value 1 to 6 X, Y, Z	-9999.999 to 9999.999	This is the ***"XYZ coordinates displayed on the teach pendant"***. After moving the robot's TCP to the sampling points carefully, ***check the displayed coordinates on the teach pendant (axis position monitor)*** and input those values on this setting item. Although there are 2 types of setting (<Record position> and <Number input>), please use <Record position> in normal case. Manually move the robot TCP carefully, and then register the coordinates by pressing the teach pendant key in the order of [ENTER] -> [RECORD]. (Apply this operation for the all sampling points)

Setting example

Using an example like the following picture, the setting procedure of this function is explained hereinafter.



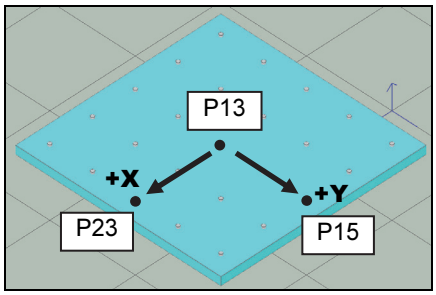
The coordinates of each points

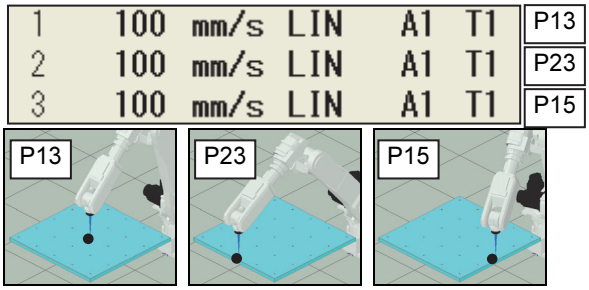
No.	Machine coordinate system (Robot coordinate system)			User coordinate system 1			Remarks
	X	Y	Z	X	Y	Z	
P1	600	-400	500	-400	-400	0	
P2	600	-200	500	-400	-200	0	
P3	600	0	500	-400	0	0	
P4	600	200	500	-400	200	0	
P5	600	400	500	-400	400	0	
P6	800	-400	500	-200	-400	0	
P7	800	-200	500	-200	-200	0	
P8	800	0	500	-200	0	0	
P9	800	200	500	-200	200	0	
P10	800	400	500	-200	400	0	
P11	1000	-400	500	0	-400	0	
P12	1000	-200	500	0	-200	0	
P13	1000	0	500	0	0	0	User coordinate system definition point 1
P14	1000	200	500	0	200	0	
P15	1000	400	500	0	400	0	User coordinate system definition point 3
P16	1200	-400	500	200	-400	0	
P17	1200	-200	500	200	-200	0	
P18	1200	0	500	200	0	0	
P19	1200	200	500	200	200	0	
P20	1200	400	500	200	400	0	
P21	1400	-400	500	400	-400	0	
P22	1400	-200	500	400	-200	0	
P23	1400	0	500	400	0	0	User coordinate system definition point 2
P24	1400	200	500	400	200	0	
P25	1400	400	500	400	400	0	

(NOTE) The pitch of the grid is 200[mm]

(1) How to create a User Coordinate System

Create a User Coordinate System 1 using the following 3 points.

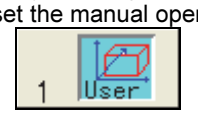




See “4.14.1 Setting example” also

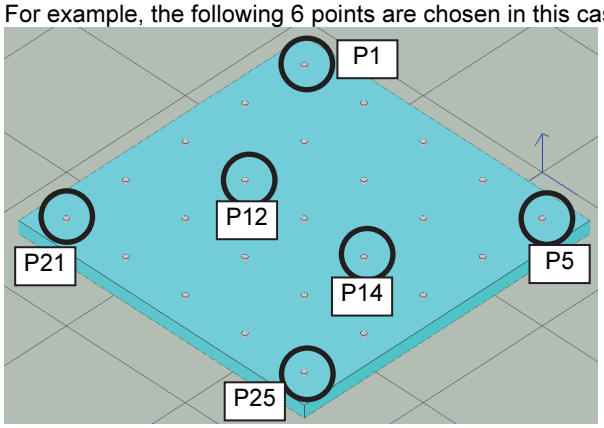
(2) Register the “User Coordinate System 1” as a manual operation coordinate system

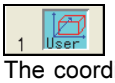
By referring to “***Register the user coordinate system to the manual operation coordinate system***” (p4-89), set the manual operation coordinate system to “User1”.



(3) Choose 6 sampling points

For example, the following 6 points are chosen in this case.





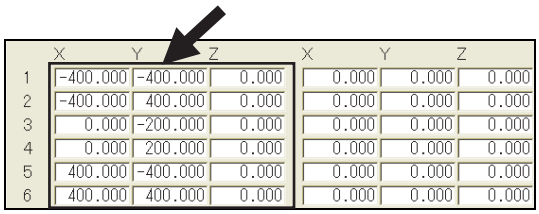
The coordinates based on the user coordinate system 1

No.	X	Y	Z
P1	-400	-400	0
P5	-400	400	0
P12	0	-200	0
P14	0	200	0
P21	400	-400	0
P25	400	400	0

* P13 is the origin of the user coordinate system 1.

(4) Set the ***“Measure value”*** for the 6 sampling points

Set the XYZ values based on the ***User Coordinate System 1***.



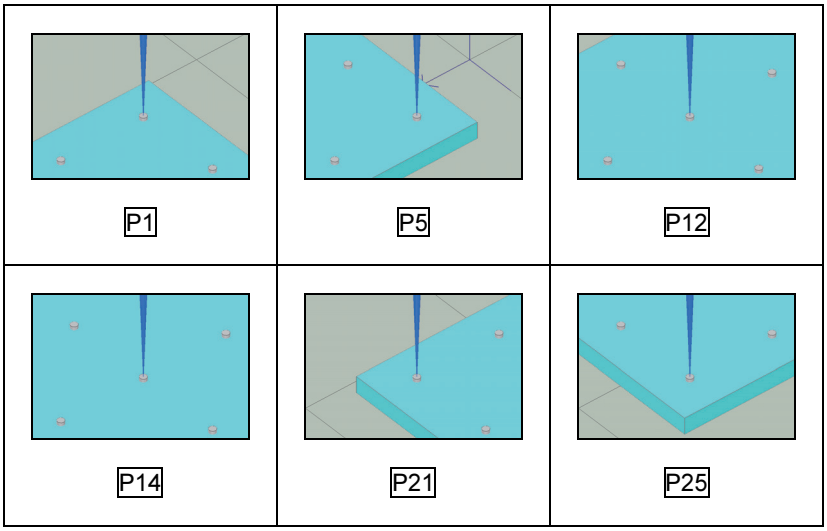
	X	Y	Z	X	Y	Z
1	-400.000	-400.000	0.000	0.000	0.000	0.000
2	-400.000	400.000	0.000	0.000	0.000	0.000
3	0.000	-200.000	0.000	0.000	0.000	0.000
4	0.000	200.000	0.000	0.000	0.000	0.000
5	400.000	-400.000	0.000	0.000	0.000	0.000
6	400.000	400.000	0.000	0.000	0.000	0.000

POINT

In this case, the coordinates on the design drawing or the coordinates that are measured from the actual work-piece can be used. Do not use the values displayed on the “Axis position monitor” of the teach pendant.

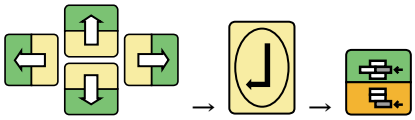
(5) Set the ***"Monitor value"*** for the 6 sampling points

Move the robot's TCP manually and accurately to the respective points that were set in the procedure (4). Then register those coordinates for ***"Monitor value"*** using the <Record position> screen. In this case, please pay attention to adjust the position of the robot's TCP to the sampling point as accurate as possible.



<How to record the position>

At each point, select the concerned line using cursor keys and then press [ENTER] and [RECORD] to register the coordinates.



(Example) After moving the robot to the P5 and recording the coordinate;

	X	Y	Z	X	Y	Z
1	-400.000	-400.000	0.000	-400.350	-400.297	-0.620
2	-400.000	400.000	0.000	-400.244	399.739	-0.864
3	0.000	-200.000	0.000	0.000	0.000	0.000
4	0.000	200.000	0.000	0.000	0.000	0.000
5	400.000	-400.000	0.000	0.000	0.000	0.000
6	400.000	400.000	0.000	0.000	0.000	0.000

POINT

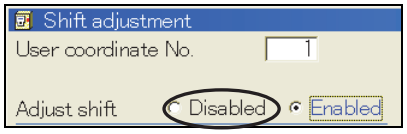
- To avoid a careless mistake, it is strongly recommended to use <Record position> screen.
- Without fail, visually check that the robot TCP and the sampling point matches accurately when pressing the  [RECORD] key.

Sample program

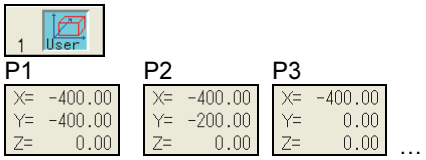
Teaching (Programming) example using “Robot Language”

1	**REM "USER COORDINATE SHIFT CORRECTION"**	
2		
3	**REM "---- INITIALIZATION OF THE SHIFT VALUE ----"**	**Initialization of the shift value**
4	V1! = 0 ' dX	
5	V2! = 0 ' dY	
6	V3! = 0 ' dZ	
7	V4! = 0 ' thetaX	
8	V5! = 0 ' thetaY	
9	V6! = 0 ' thetaZ	
10	CHGCOORD 1	Select the User Coordinate System 1
11		
12	**REM "---- MOVE TO HOME POSITION ----"**	**Move to the home position**
13	MOVEX A=1,M1J,P,(0, 90, 0, 0,-90, 0),R=10.0,H=1,MS	
14		
15	**REM "---- MOVE TO GRID COORDINATES ----"**	**Move to the coordinates on the calculated grid**
16	FOR V1% = 0 TO 4 STEP 1	X direction loop
17	FOR V2% = 0 TO 4 STEP 1	Y direction loop
18		
19	**REM "---- X SHIFT ----"**	**Calculate the dX (-400 is the offset for the start point) P1)**
20	V1! = 200 * V1% - 400.0	
21	**REM "---- Y SHIFT ----"**	**Calculate the dY (-400 is the offset for the start point P1))**
22	V2! = 200 * V2% - 400.0	
23		
24	**REM "---- SHIFT REGISTER ----"**	**Put the calculation result to the shift register**
25	R1 = (V1!,V2!,V3!,V4!,V5!,V6!)	
26		
27	**REM "---- SHIFT START (USER COORDINATE 1) ----"**	
28	SHIFTR 1, 2, R1, 10000	Start the shift motion (Based on the user coordinate system)
29		
30	**REM "---- MOVE TO THE TEACH POINT ----"**	**Move to the origin of the User coordinate system**
31	MOVEX A=1,M1X,L,(0,0,0,0,0,0)U,R=10.0,H=1,MS	
32	DELAY 1	Stop for 1 second
33		
34	**REM "---- SHIFT END ----"**	
35	SHIFTR 0, 2, R1, 10000	Finish the shift motion
36		
37	NEXT	The end of the Y direction loop
38	NEXT	The end of the X direction loop
39		
40	END	Program End

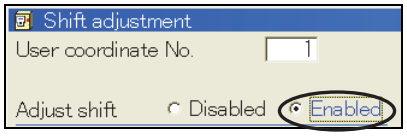
When this function is “Disabled”



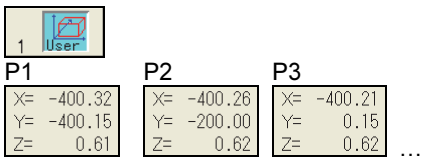
When reaching the teach point, the value in the “Axis position data monitor window” is the same as the calculated shift data. But the actual position of the TCP (Tool Center Point) is in the inaccurate position because of the position error caused by many characteristics.



When this function is “Enabled”



When reaching the teach point, **the value in the “Axis position data monitor window” is not the same as the calculated shift data.** But, while the user coordinate shift operation is executed, because this function works, the actual position where the robot’s TCP reaches is more accurate than the case of “Disabled”



4.15 How to copy the software-key settings between the controllers

It is possible to copy the software-key settings between the controllers. (Import / export)
This function is convenient when it is necessary to use several controllers with a same setting.

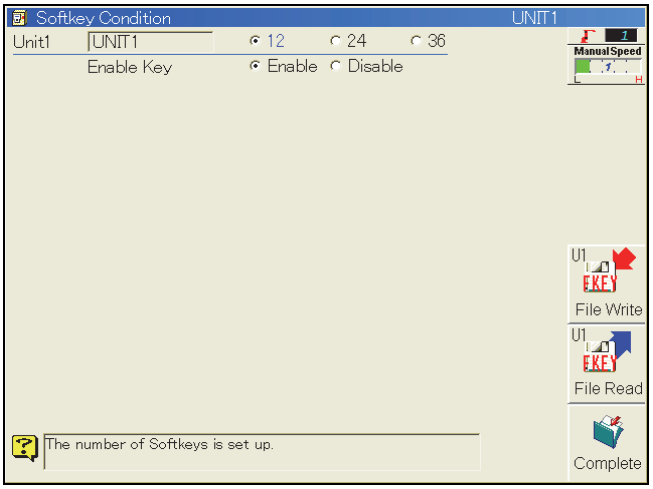
This operation should be performed after switching the operator class to ***EXPERT*** or higher.

4.15.1 Exporting the setting file

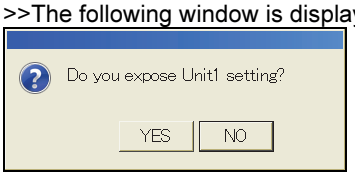
Let's export the soft-key setting to the USB memory (RC Ex.Mem1).
(Please insert an USB memory to this robot controller in advance.)

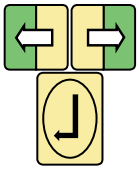
Operating procedure

1 **Open <Constant Setting> - [7 f-Keys] [1 Softkey Condition].**

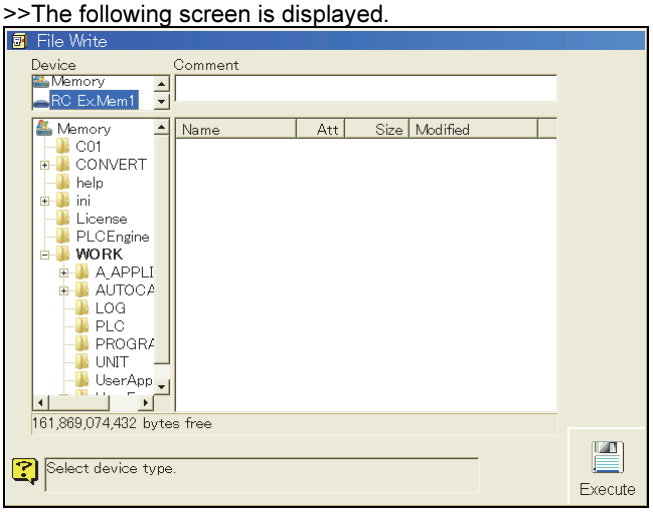


2 **Press <File Write>**
>>The following window is displayed.

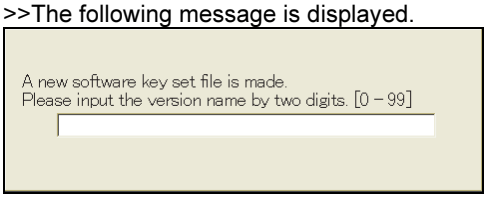


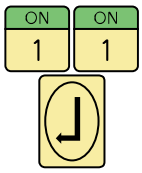


3 **Select “YES” and then press [Enter].**
>>The following screen is displayed.

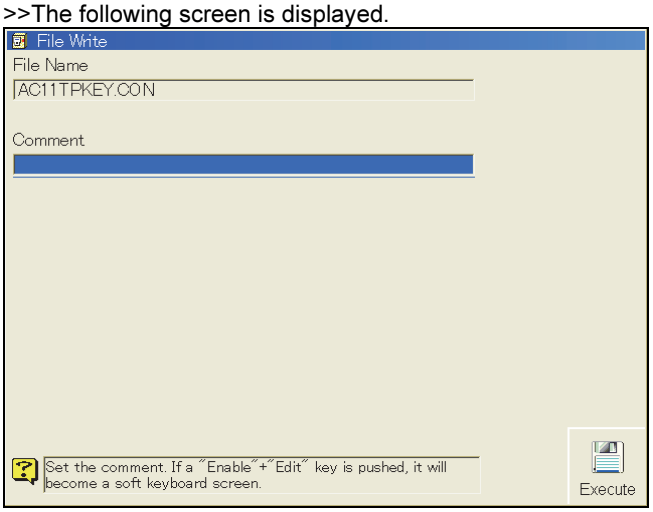


4 **After selecting the destination folder for the export (In this case, “RC Ex.Mem1”), press <Execute>.**
>>The following message is displayed.

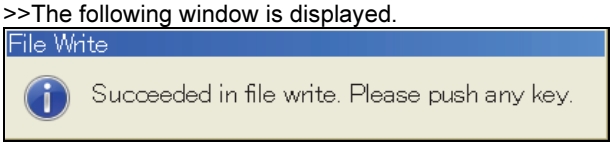




5 **Input the 2 digits (00-99) and press [Enter]. In this example, input “11” and press [Enter].**
>>The following screen is displayed.



6 **(If necessary) input the comment and press <Execute>.**
>>The following window is displayed.



>>In this example, the setting will be exported with the following file name.
AC**11**TPKEY.CON

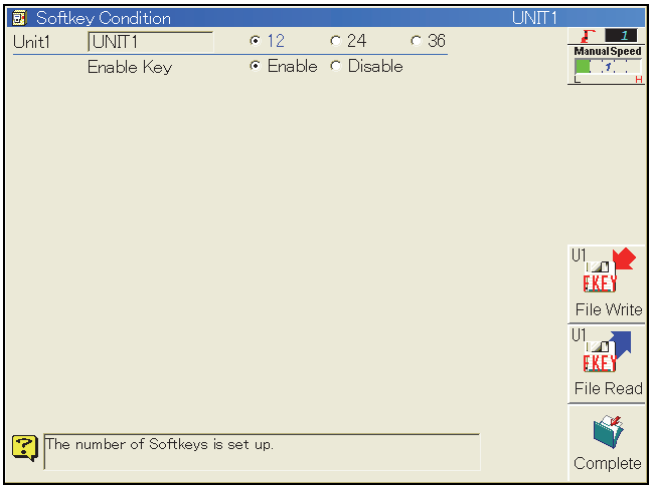
7 **Connect the USB memory to the other FD controller.**

4.15.2 Importing the setting file

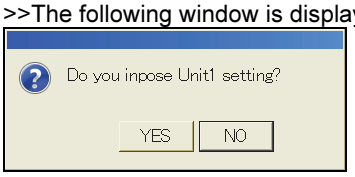
Let's import the setting file that was exported to the USB memory in the previous section.
(Please insert the USB memory to the robot controller in advance.)

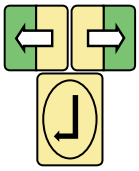
Operating procedure

1 **Open <Constant Setting> - [7 f-Keys] [1 Softkey Condition].**

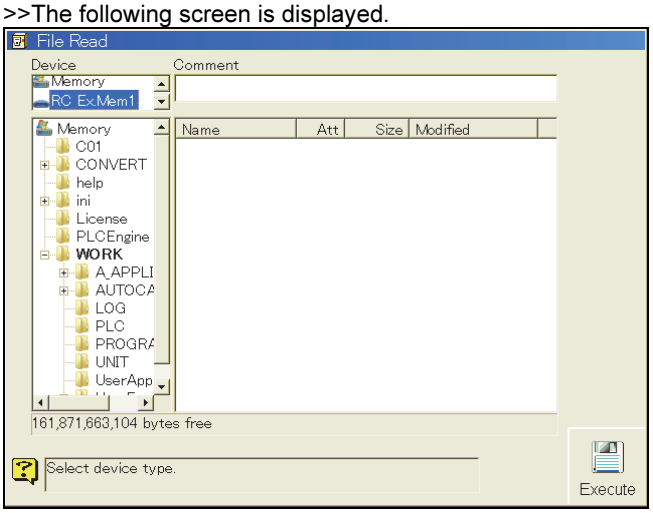


2 **Press <File Read>**
>>The following window is displayed.



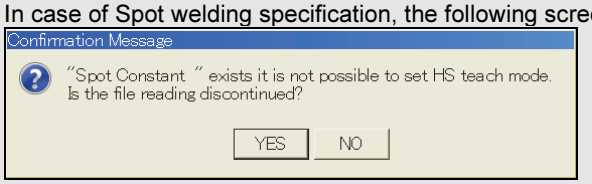


3 **Select "YES" and press [Enter].**
>>The following screen is displayed.



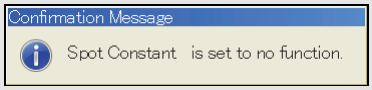
4 **Select the "AC**TPKEY.CON" in the USB memory (RC Ex. Mem1) using the [Cursor key] and the [Enter] key and then press <Execute>.**
>>The file is imported and the following window will be displayed.

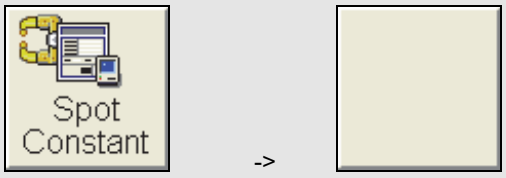
In case of Spot welding specification, the following screen may be displayed.



Normally, select “NO”. When “NO” is selected, the ***“Spot Constant (CODE 2082)”*** softkey is automatically changed to ***“No function (CODE 0)”***.

POINT





5 **Press <Complete>.**
>>The settings will be effective.

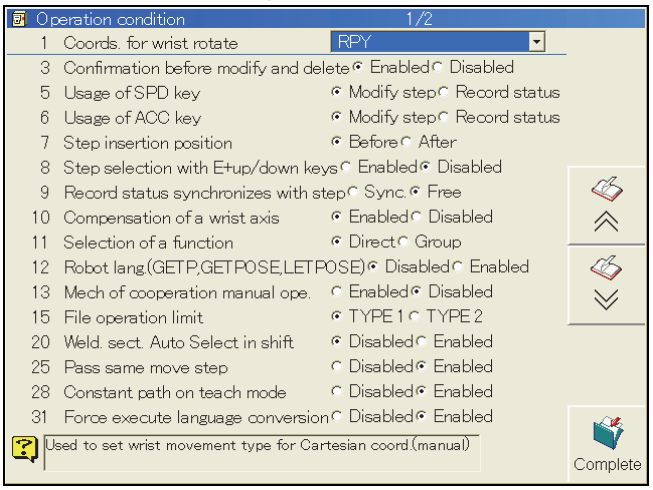
4.16 Operation condition

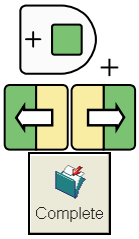
4.16.1 Operation condition

Normally, it is not necessary to change the settings in this screen. However, if you prefer to change the settings, you need to have an operator class of ***EXPERT*** *or higher.*

Setting procedure

1 **Open <Constant Setting> - [5 Operation Constants] [1 Operation condition].**





2 **Change the setting for the respective items.**

3 **Press <Complete>.**
>>The settings will be saved in the memory.

Table 4.16.1 Operation condition

No.	Item	Description
36	Ground angle fixed motion	This setting decides if the 3rd axis will move when the 2nd axis moves. <Disabled> The 3rd axis will not move when the 2nd axis moves. <Enabled> The 3rd axis will move to keep its angle against the ground when the 2nd axis moves. (NOTE) This is available in the system software FDV03.17 or after.

For other items, refer to the help function.

4.17 Setting the “Playback speed limit”

It is possible to limit the maximum speed of the TCP (Tool Center Point) in the playback mode or the check go operation.
While this function is enabled, the robot cannot exceed the limit speed in spite of the recorded speed of the step data. Even if the playback speed override value is larger than 100%, the robot cannot exceed the limit speed.
And, if the recorded speed of the step data is written in “%”, the setting value of this function is regarded as 100%.

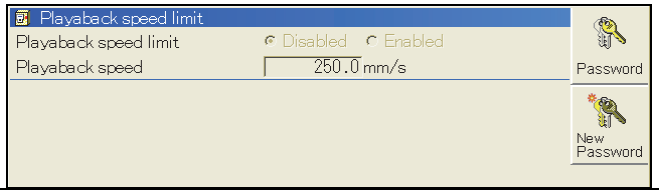
When shipping the robot, this function is “Disabled”.

4.17.1 Setting

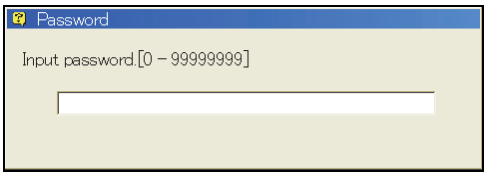
Select the operator class ***EXPERT*** or higher in advance.

Setting procedure

1 **Open <Constant Setting> - [3 Machine Constants] [36 Playback speed limit].**



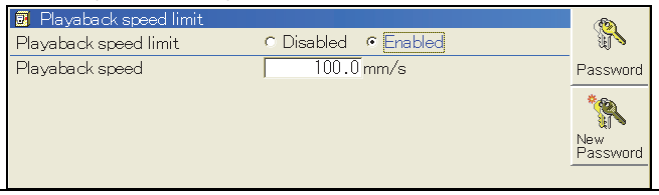
2 **The setting is protected by a password.**
>>Touch the “Password” ICON.



Enter the password.

- For the password, numbers of 8 digits or less and “+” or “-“ can be used.
- The initial setting (factory setting) is “” (no password).
- When this screen is closed, it is necessary to enter the password again.

3 **After inputting the correct password, it becomes possible to change the setting.**
>>Change the setting.



4 **Press <Complete> to save the setting to the internal memory.**

Table 4.17.1 Playback speed limit

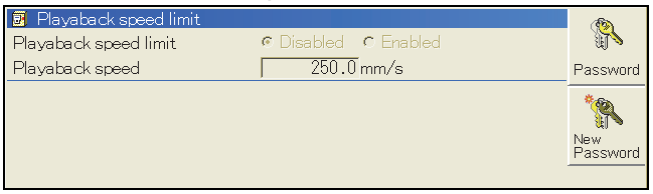
Item name	Description
Playback speed limit	Enable / Disable this function.
Playback speed	Set the maximum speed of the TCP (Tool Center Point) [0.0 to 250.0 mm/s] (NOTE) “0.0” means “Disable”.

4.17.2 How to change the password

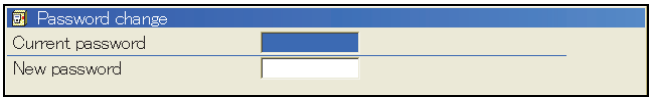
The password can be changed.

Setting procedure

1 **Open <Constant Setting> - [3 Machine Constants] [36 Playback speed limit].**



2 **Touch the “New Password”.**



3 **Enter the Current password and the New password.**

- For the password, numbers of 8 digits or less and “+” or “-“ can be used.
- The initial setting (factory setting) is “” (no password).

4 **Press <Complete> to save the setting to the internal memory.**

Table 4.17.2 Password change

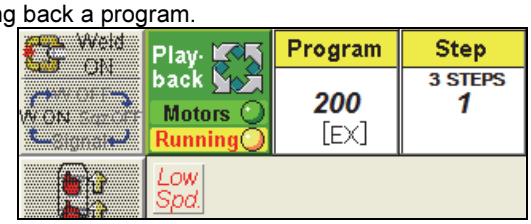
Item name	Description
Current password	Enter the current password. The inputted numbers are displayed as “*”. If this password is not correct, the password cannot be changed. In case of “no password”, leave this item empty.
New password	Enter the new password. For the password, numbers of 8 digits or less and “+” or “-“ can be used. In case of “no password”, leave this item empty.

IMPORTANT

If you forget the password, it is impossible to release the protection. Please be careful.

4.17.3 Playback mode

If the ***“Playback speed limit” function”*** is enabled, an ICON like the following picture will be displayed while playing back a program.

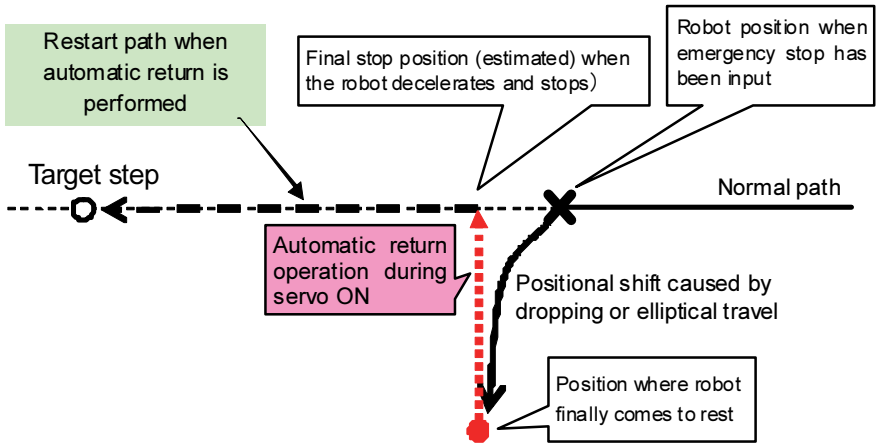


4.17.4 Teach mode

If the ***“Playback speed limit”*** function is enabled, the manual operation speed is also limited. (In this case, there is no specific display)

4.18 Position resume setting

When emergency stop has been initiated during a playback operation, the robot may stop at a position which is slightly off its normal path. If operation is restarted with the robot at this position, the robot will pass along a route that is at variance from its correct path, giving rise to the risk that the robot will interfere with the peripheral devices. By using this function, the robot can be made to take the safe route when operation is restarted, precluding the possibility that interference trouble will occur.

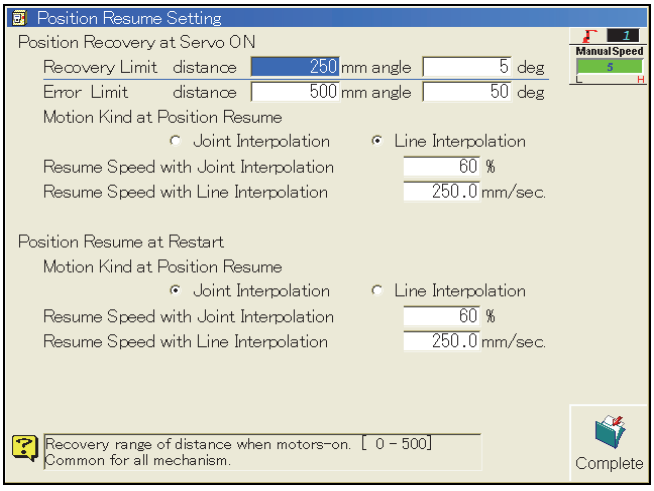


4.18.1 Setting

Select the operator class ***EXPERT*** or higher in advance.

Setting procedure

1 **Open <Constant Setting> - [3 Machine Constants] [10 Position Resume Setting].**

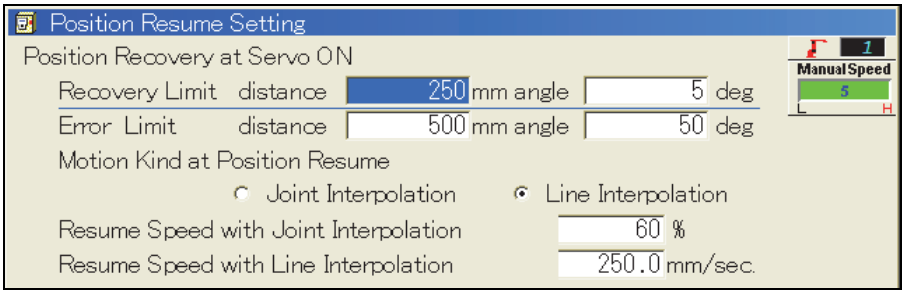


2 **Set the respective parameters.**

3 **Press <Complete> to save the setting to the internal memory.**

4.18.2 Position recovery at Servo ON

The posture at the position on the command path when the motor power is turned off is stored in the memory, and the robot is automatically moved to return to that posture when the motor power is turned back on. This means that, when restart is initiated, the same path is drawn as the one drawn under normal circumstances. This function is also called the "Previous position return function."

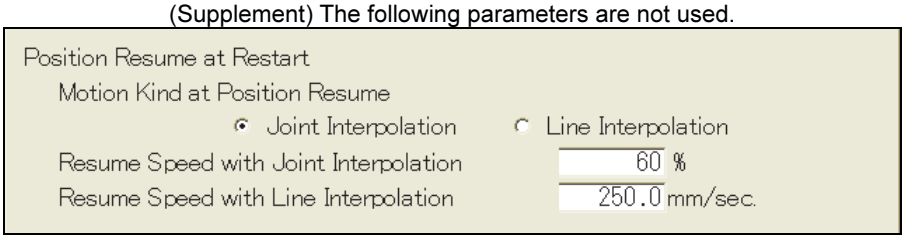


The differences in the position and posture between the time when the motor power is turned off and the time when it is turned back on are defined by the differences in the distance of the tool tip position and angle (robot wrist posture), and whether to perform the return operation or not is set depending on the extent of these differences.

Table 4.18.1 Position Recovery at Servo ON

Setting item	Description
Recovery Limit	If both the distance and angle are within the values set here, the automatic return operation is performed. If the distance or the angle has exceeded the value set here, an “Information” message appears when the motor power is turned on, and the return operation is not performed. If the distance has been set to 0 mm, the return decision is not based on the distance. If the angle has been set to 0 degrees, the return decision is not based on the angle. If both the distance and angle have been set to zero, the automatic return function which is performed when the servo is turned on is canceled.
Error Limit	If the distance or the angle has exceeded the value set here, an error is detected when the motor power is turned on, and operation cannot be started until the error reset operation is performed. After that, the robot cannot restart until one of the following operations is performed. (1) Step set (2) Servo ON operation in Teach or Playback mode (3) Power OFF and ON of the primary power supply switch
Motion kind at Position Resume	This is used to select either joint interpolation or linear interpolation as the interpolation type for the automatic return operation.
Resume Speed with Joint Interpolation	This is used to specify the speed for joint interpolation.
Resume Speed with Line Interpolation	This is used to specify the speed for linear interpolation. The low safety speed (250 mm/sec.) is the safe speed.

(Supplement) The following parameters are not used.



4.19 User help function

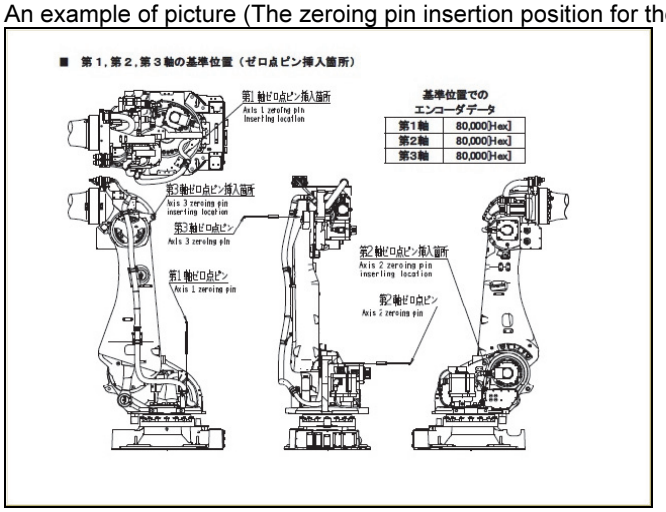
4.19.1 Outline

The “User help” is a function to display the image files created by users on the teach pendant screen. It is possible to register the image files (BMP/JPEG/GIF) up to 100 files

(Examples of pictures)
- Program start procedures
- Precautions about the robot
- Troubleshooting procedure
- Spare parts list
- Instruction manual list
- How to contact the maintenance engineers

etc.

An example of picture (The zeroing pin insertion position for the J1 to J3 axis)



POINT

The picture files for this function must be placed in the external memory storage (USB memory attached to the USB port of the CPU board) always. Therefore, even after the registration operation, the file must stay in the USB memory of the CPU board. Without the USB memory, the user help screen cannot be displayed.

4.19.2 Available image file formats

The available image formats for this user help function is shown in the following table.

Format	BMP, JPEG, GIF
File name extension	bmp, jpg, jpeg, gif
Image size	1280x1024 pixels or less (640x480 is recommended)
Number of colors	24 bit color or less
File path	The folder in the robot controller external memory device “RC EX Mem” (USB memory) /HELP/

However, because the teach pendant screen resolution is 640 x 480 pixels (VGA), a larger/smaller image than this will be enlarged/reduced. Especially, in case of large image, small letters will get very small and it may be difficult to read. So an image of 640 x 480 is recommended. And, 2 image files that have the same name and the different file name extension cannot be registered at the same time. (E.g. “*image,jpg*” and “*image.bmp*” cannot be used at the same time)

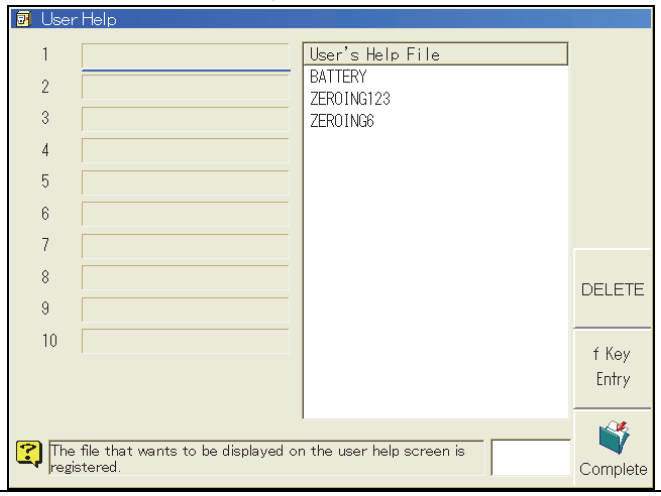
4.19.3 How to register the image file

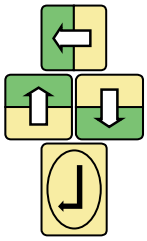
For this setting operation, operator class of ***SPECIALIST*** .is necessary.
Change the operator class using the Shortcut command R314 in advance.
(The initial password is “12345”)

To register an image for this function, please follow these setting procedures.

Operating procedure

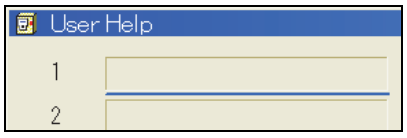
1 **Open <Constant Setting> - [38 User Help].**



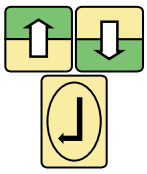


2 **Press Left cursor key to select the Registration window.**

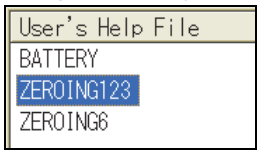
Using up/down cursor keys to select the registration number and then press [Enter].



(In this example, 1 is selected)

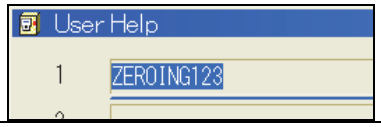


3 **The cursor will move to the right side of the screen. Select the desired image file using cursor key and press [Enter].**



In this example, an image file “/HELP/ZEROING123.jpg” (placed in the ***“RC Ex. Mem”***: external USB memory device) is selected. Please be sure that the file name extension is not displayed in this screen.

4 **Now an image file “ZEROING123” is registered to the user help number 1.**



5 **Press <F12> key.**

>>The setting is saved in the internal memory.

(NOTE) To release the registered image file, use <DELETE> key.

4.19.4 How to display the user help image

To display the user help image, it is necessary to assign the user help function to the software-key in advance.

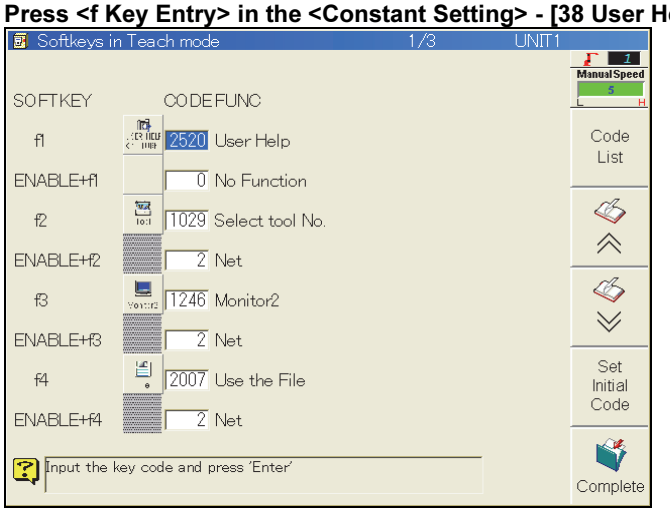
"USER HELP" software-key (CODE is 2520)

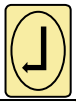
In this case, as an example, let's assign the software-key in the Teach mode.
(However, the User Help software-key can be assigned both for the Teach mode and the Playback mode)

Operating procedure

f Key Entry

1 Press <f Key Entry> in the <Constant Setting> - [38 User Help] screen.





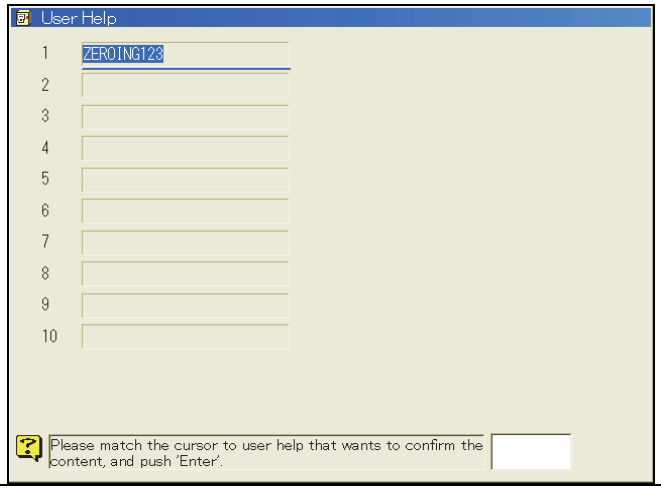
Complete

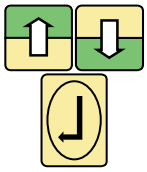
2 Input "2520" for the f1 key and press [Enter]. Then press <Complete>.
>>The setting is saved in the internal memory.

3 The "USER HELP" software-key is displayed as the f1-key in the Teach mode screen.

4 **Press the software-key [USER HELP].**

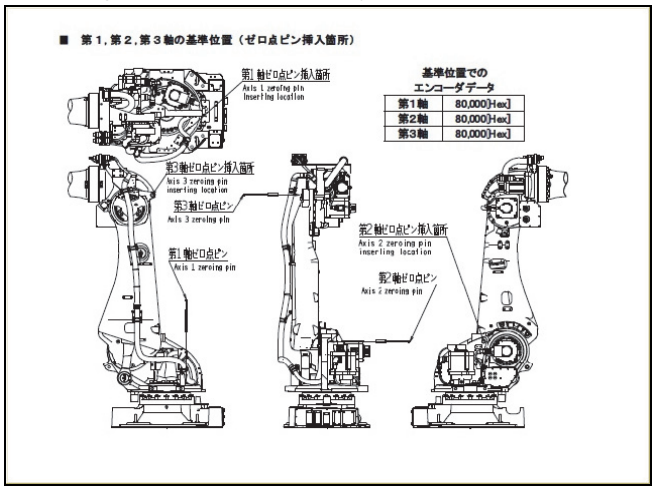
>>The following screen is displayed.





5 **Select the "ZEROING123" and press [Enter].**

>>The registered picture is displayed.



6 **Press [R] key to close the screen.**

4.19.5 Setting file “USERHELP.con”

The settings for the user help function is recorded in the plain text file ***“USERHELP.con”*** in the WORK folder. An example of this file is shown below. It is also possible to setup the user help function by creating / editing this text file.

```
[USER_HELP]
HELP01="FileName"
HELP02=""
HELP03="HowToUse"
HELP04=""
HELP05="ExampleOfUserHelp"
HELP06=""
HELP07=""
HELP08="HowToReleaseTheError"
HELP09=""
HELP10=""
```

(NOTE)
- The double quotation mark must be half-size character.
- The filename extension (e.g. “jpg”, “bmp”, etc.) is not necessary.

(Example) If the filename is ***“ZEROING123.jpg”***, write the file like ***“ZEROING123”***.

Concerning the folder structure of the memory, refer to the instruction manual “BASIC OPERATIONS”.

4.19.6 Trouble shooting

Error message
“Specified user's help file does not exist, or unsupported file.”

Cause

(1) The file does not exist in the designated folder.
(2) The [Enter] key is pressed at the help number that is not set.
(3) The file format is not supported.
(4) The BMP/JPG/GIF file is broken.

Measure

(1) Please check that the “RC EX Mem” (=USB memory), the “HELP” folder exists in the memory, the designated image file is in the HELP folder, etc.
(2) Register a help image at first.
(3) Only BMP/JPG/GIF format can be displayed. Please check the image file format.
(4) Please check that the image file is not broken or not.

Error message
“The writing of a constant file went wrong.” / “The configuration file is protected or it is broken.”

Cause The setting file “USERHELP.con” is protected.

Measure Please check that the setting file is protected or not. If protected, release the protection setting.

<MENU>
[Service Utilities] – [7 File Manager] [4 File Protect]

Not protected

Protected (“1” stands for the protected file)

NOTE

Chapter 5 Spot welding setup

This chapter is aimed at operators who intend to use the robot for spot welding applications, and it describes the setup work specifically for these applications.

CAUTION

Details on Spot welding function

For details on “Spot welding function” refer to the instruction manual listed below.

“Application/ Spot welding”
Japanese TFDJP-004
English TFDEN-004

CAUTION

For the customer, prefer to set up Servo guns by yourself

It is necessary for you to do all the settings by yourself, including pressure adjustment of the servo gun and the encoder zeroing setting etc. In case that these settings haven’t been set, then you cannot conduct any operations including servo gun and teaching/playback of the spot welding program correctly.

Please refer to the following manual listed below for the details of setting.
“For EXPERT Operator Servo gun Adjustment Procedure”
Japanese TFDJP-044
English TFDEN-044

5.1 Overview of setup work

Depending on the drive system of the welding gun used, spot welding is classified into two kinds: "air gun" and "servo gun." The air welding gun is driven pneumatically whereas the servo welding gun is driven by servo control.

Due to differences in the control method, the steps taken for setup differ between the two kinds of spot welding.

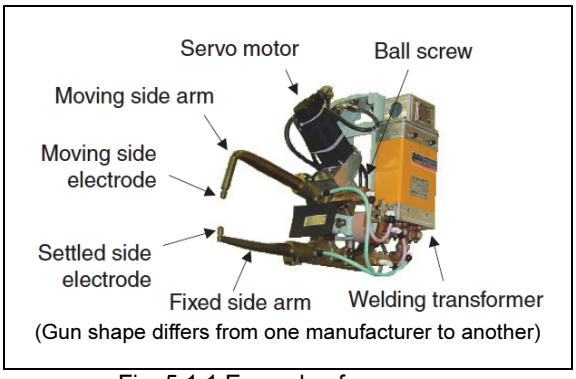


Fig. 5.1.1 Example of servo gun

Many more steps need to be taken for the setup in the case of a servo gun compared with an air gun since a servo gun involves the registration of machine constants—specifically the "mechanism constants" for exercising servo control over the gun axes—and of the servo tuning parameters, the measurement of the bending characteristics, and so on.

(1) If a servo gun is attached before our factory shipment

It is shipped with the setup of the shaded area completed beforehand.

(2) If a servo gun is attached after our factory shipment

The attachment of a servo gun and the setup of the shaded area must be carried out by the customer. High-level knowledge on the robot and servo gun and time are required for the setting.

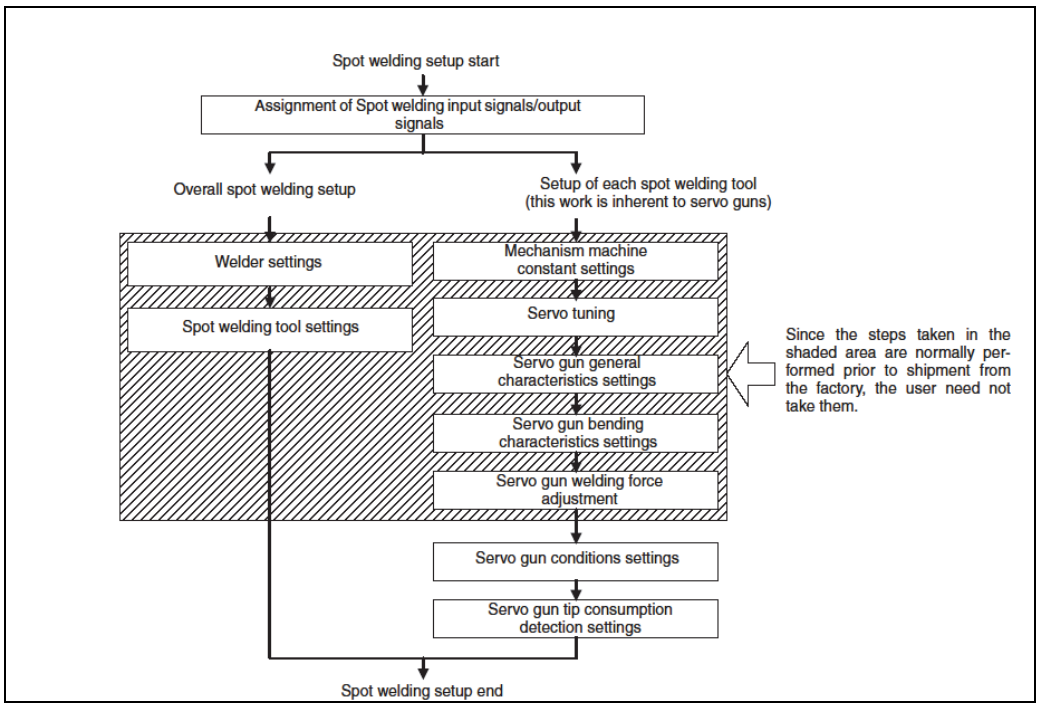


Fig. 5.1.2 Overview of spot welding setup work

In this chapter, only areas other than the shaded area are explained.

5.2 Assignment of spot welding input/output signals

In this section, the signal attributes used specifically for spot welding applications will be described. These signals include the gun pressure output signal and welding completed (WI) input signal. Whereas the basic signal attributes are used as the standard signals with all applications, the signals described in this section are used only for spot welding applications.
The operating procedure for assigning the signal attributes is exactly the same as for the basic signal attributes. If the robot delivered has "spot welding" set as its application, some of the signals were already assigned at the factory.

Among the signals are the ones used with air guns only, the ones used with servo guns only, and the ones used for both types of guns. "○" in the table denotes a signal which is used. "–" denotes a signal which is not used even if it has been assigned.

As for the signal that is not written here, please refer to the instruction manual “APPLICATION MANUAL SPOT WELDING”.

5.2.1 Spot welding input signals

Table 5.2.1 Spot welding input signals

<table>
<tr><th>Basic input signal designation</th><th>Factory-set Input signal</th><th colspan="3">Function</th><th>Air Gun</th><th>Servo Gun</th></tr>
<tr><td>Weld complete (WI)

W2 to W6</td><td>26
(Connector pin#34)
0</td><td colspan="3">This signal requests that the fact that the welding has been completed be input from the welder (timer contactor).
When this signal is input, the gun release is started in order for the gun to move to the next step.</td><td>○</td><td>○</td></tr>
<tr><td>In weld</td><td>27
(Connector pin#35)</td><td colspan="3" rowspan="2">Welding ON, welding OFF or pressurizing OFF is selected by means of external signals. The combinations of these signals are presented below. For the individual statuses, refer to the "Basic spot welding operations" in the Basic Operations Manual.
Welding ON and welding OFF can be switched by means of external signals only when the "Welding On/Off" spot welding condition has been set to "Signal." The pressurizing OFF status, however, is established simply as a result of the input of the pressurizing OFF signal regardless of this setting.</td><td>○</td><td>○</td></tr>
<tr><td>No squeeze</td><td>0</td><td>"Weld ON" Input signal</td><td>"Pressurizing OFF" Input signal</td><td>Status</td><td>○</td><td>○</td></tr>
<tr><td></td><td></td><td>ON</td><td>ON</td><td>→Pressurizing OFF</td><td></td><td></td></tr>
<tr><td></td><td></td><td>ON</td><td>OFF</td><td>→Weld ON</td><td></td><td></td></tr>
<tr><td></td><td></td><td>OFF</td><td>ON</td><td>→Pressurizing OFF</td><td></td><td></td></tr>
<tr><td></td><td></td><td>OFF</td><td>OFF</td><td>→Weld ON</td><td></td><td></td></tr>
</table>

5.2.2 Spot welding output signals

Table 5.2.2 Spot welding output signals

Basic Output signal designation	Factory-set Output signal	Function	Air Gun	Servo Gun
Gun squeeze	17 (Connector pin#19) 0	This is output when the step in which the spot welding command (SPOT: FN119) has been recorded is played back. It is also output during manual pressurizing operations in the teach mode. Only welder 1 (W1) is initially assigned.	○	○
Gun Full open	18 (Connector pin#20) 0	This is the signal for opening the air gun fully. It is output when semi-open has been set with "Stroke" in the spot weld sequence. Only welder 1 (W1) is initially assigned.	○	–

Basic Output signal designation	Factory-set Output signal	Function	Air Gun	Servo Gun
Gun half open	0	This is the signal for opening the air gun halfway. It is output when semi-open has been set with "Stroke" in the spot weld sequence.	○	—
Weld command	0	This is output when the "Weld Signal" in the spot welding sequence has been set to "Output provided" and the spot welding command is played back in the welding ON status.	○	○
Weld condition	0	The "Welding condition output data" which has been set as the spot welding conditions is output. The signal range from 1 to 16.	○	○
Pressure ctrl	0	In the case of an air gun, the [Pressure control] data specified by the spot welding conditions is output discretely. Use this when air guns that employ an electropneumatic proportional valve, etc. to control the welding force are used. The signal range from 1 to 3.	○	—
Welder warning	19 (Connector pin #21)	<This function is not supported at the present time.>	○	○

5.3 Settings only for a servo gun

When an air gun is used, there is no need to read through this section.

A number of technical terms relating to spot welding will appear in this section. To find out what these terms mean, read through the section on basic spot welding operations in the Basic Operation Manual before proceeding.

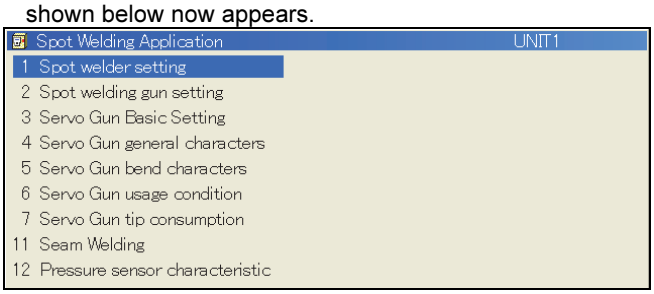
The "servo gun usage conditions" and " servo gun tip consumption " parameters that are concerned with how to determine the position of the open stroke and other aspects of operating the servo gun are set here. Prior to shipment from the factory, the general initial settings were already performed. Therefore, under normal circumstances, no changes need to be made by customer. Outlined in this section are a number of terms and parameters with which an operator must at the very least be familiar in order to proceed with the basic teaching using the servo gun.
For an explanation of all the parameters displayed, refer to the operating manual “APPLICATION MANUAL SPOT WELDING”.

5.3.1 Servo gun condition

The servo gun conditions are the general conditions that come into play when the servo gun is to be used. There are two kinds of parameters, ones which are common to all spot welding tools and ones which are for individual tools.

1 **Select the teach mode.**

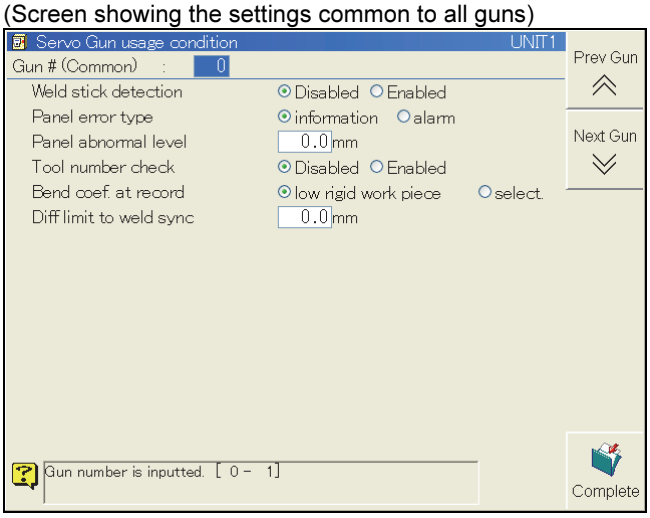
2 **Select the <Spot Constant> f key. The same menu can be selected by pressing [13.Spot welding application] from <Constant Setting> f key.**
>>The constant setting menu used exclusively for spot welding such as the one shown below now appears.



Menu items for title No.3 and following are displayed only when servo guns have been set.

3 **Align the cursor with [5 Working condition of Servo Gun] and press [Enter] key.**
>>A setting screen such as the one shown below now appears.

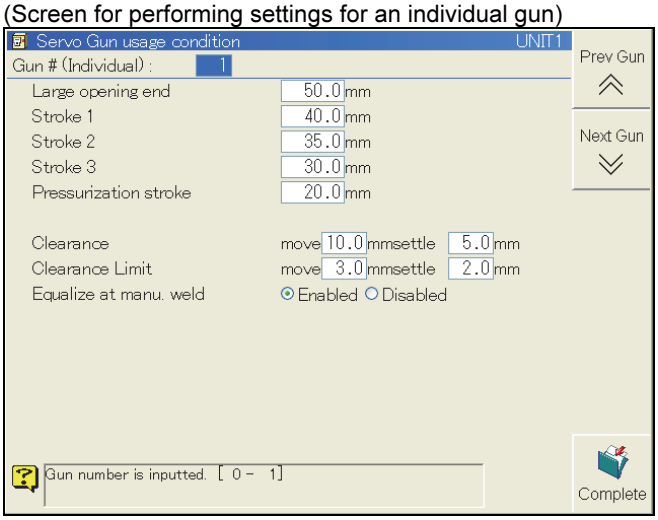
(Screen showing the settings common to all guns)

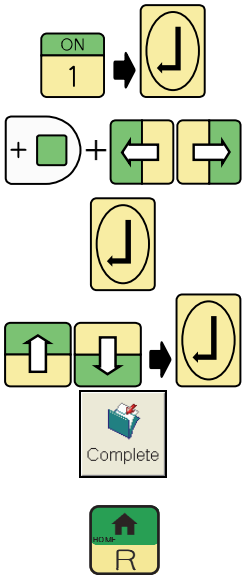


4 **The setting screen corresponding to the number of pre-defined spot welding tools now appears. If a multiple number of spot welding tools have been defined, input the number in the edit box at the very top of the screen and press the [Enter] key or press the <Prev gun> or <Next gun> f key to switch the spot welding tool number.**

5 **Some parameters are defined for each spot welding tools while others are common to all spot welding tools.**
"0" is set in the gun number field at the very top of the screen for the common parameters. Set the number "1" or above for the parameters specific to individual guns.

(Screen for performing settings for an individual gun)





6 **If there is an edit box, input the appropriate number, and press [Enter] key.**

If the radio buttons (the horizontal rows of selector buttons) are used, press the [ENABLE] and left or right cursor keys at the same time to select their settings.

If the combo box (box with the arrow at the far right) is used, align the cursor with it, and press the [Enter] key. A table with a list of selection candidates now appears. Use the up or down cursor key to select the chosen candidate, and press [Enter] key again.

7 **Upon completion of the settings, press <Complete> f key.**
The settings are written in the spot welding constant file.

(To stop editing at any time, press [RESET/R] key.)

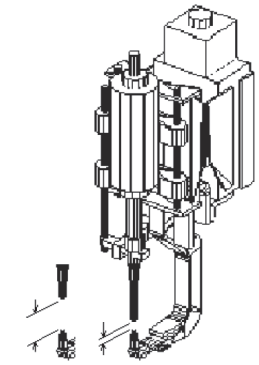
Only the basic parameters will be described below. For an explanation of all the parameters displayed, refer to the operating manual “APPLICATION MANUAL SPOT WELDING”.

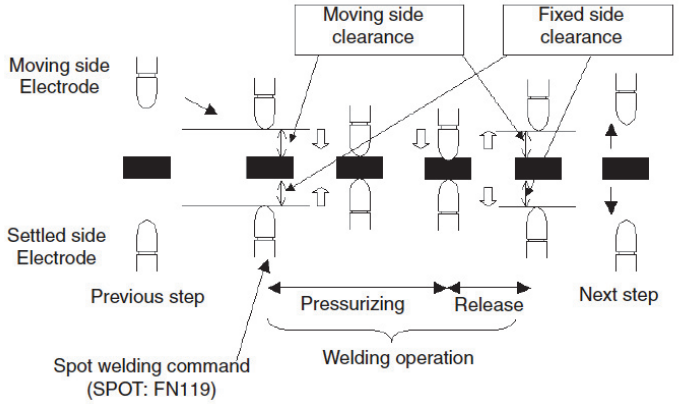
Table 5.3.1 Servo gun conditions (common data)

Parameter	Factory settings	Description of function
Bend coef. at record	Low rigid work piece	Low rigid work piece: The position is modified by the entire bending amount during step recording. Select.: This depends on the setting for "Panel rigid type " among the spot teach/playback condition menu items. If "Low rigid" applies, the position is modified by the entire bending amount; if "High rigid" applies, it is modified by the bending amount on the movement side.

Table 5.3.2 Servo gun conditions (individual data)

Parameter	Factory settings	Description of function
Large opening end	50 mm	This specifies the distance at which the moving side electrode and fixed side electrode have opened maximally during manual opening/closing. This distance must be set inside the soft limit. In the case of a gun without a battery, the gun is set to this position after returning to its home point.
Stroke 1	40 mm	Since the gun axis is servo-controlled, the gun can be stopped at any position but, with a view to facilitating the teaching process, the design enables stroke switching by a single-action operation. When the <Stroke select> f key is pressed, stroke switching operations can be performed in one go for a total of four settings, namely, stroke 1, stroke 2, stroke 3 and wide release value.
Stroke 2	35 mm	
Stroke 3	30 mm	
Pressurization stroke	20 mm	This parameter specifies the distance when the moving side electrode and fixed side electrode have closed maximally during manual opening/closing. A value lower than the large opening end default value must be set without fail.
Moving side clearance	10 mm	This parameter specifies the distance between the moving (or fixed) side electrode and the work immediately prior to pressurizing when the spot welding command (SPOT: FN119) is played back.
Fixed side clearance	5 mm	





5.3.2 Tip consumption detection

In this section, the operating conditions for determining how the gun tip consumption is to be detected (gun search) are set. These settings must be performed for all the spot welding tools that are to be used.

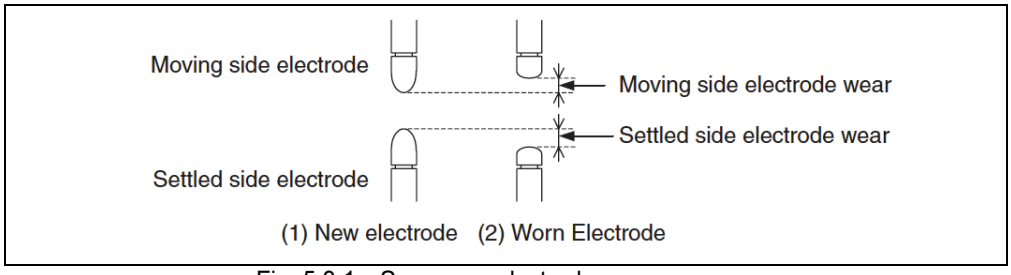
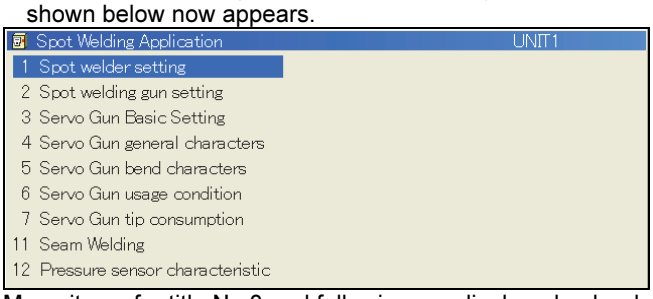


Fig. 5.3.1 Servo gun electrode wear

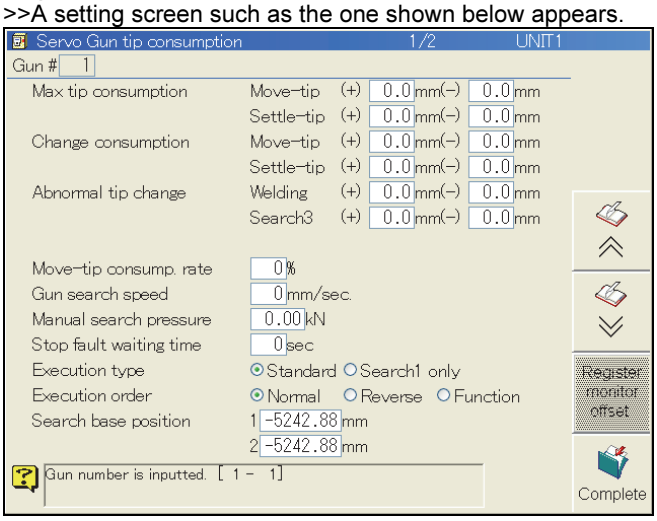
1 **Select the teach mode.**

2 **Select the <Spot Constant> f key. The same menu can be selected by pressing [13.Spot Welding Application] from <Constant Setting> f key.**
>>The constant setting menu used exclusively for spot welding such as the one shown below now appears.

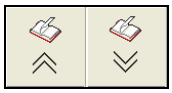


Menu items for title No.3 and following are displayed only when servo guns have been set.

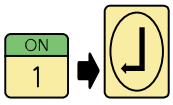
3 **Align the cursor with [6 Tip consumption detection] and pres [Enter] key.**
>>A setting screen such as the one shown below appears.



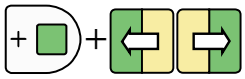
>> The number of items displayed varies depending on the operator qualification.



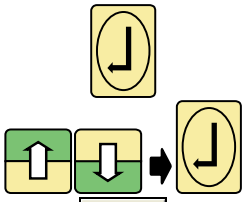
4 **The setting screen corresponding to the number of pre-defined spot welding tools now appears.**
If a multiple number of spot welding tools have been defined, input the number in the edit box at the very top of the screen and press [Enter] key or press the <Prev gun> or <Next gun> f key to switch the spot welding tool number.



5 **If there is an edit box, input the appropriate number, and press [Enter] key.**



If the radio buttons are used, press the [ENABLE] and left or right cursor keys at the same time to select their settings.



If the combo box (box with the arrow at the far right) is used, align the cursor with it, and press [Enter] key. A table with a list of selection candidates now appears. Use the up or down cursor key to select the chosen candidate, and press [Enter] key again.

6 **Upon completion of the settings, press the <Complete> f key.**
The settings are saved in the spot welding constant file, and the editing screen is closed.

(To stop editing at any time, press [RESET/R] key.)

Only the basic parameters will be described below. For an explanation of all the parameters displayed, refer to the operating manual “APPLICATION MANUAL SPOT WELDING".

Table 5.3.3 Tip consumption detection

Parameter	Factory settings	Description of function
Move-tip consump. rate	0%	If the tip consumption is to be detected using gun search 1 alone or using gun searches 1 and 3 together, only the "total tip consumption," which is obtained by adding the moving side electrode tip consumption and fixed side electrode tip consumption, can be detected. Using the value set here, the "total tip consumption" is divided into two parts, the moving side electrode tip consumption and the fixed side electrode tip consumption. (This parameter cannot be used with gun search 2.)

Chapter 6 Preparations for automatic operation

This chapter describes the usual preparatory steps taken to operate the robot automatically.

6.1 How to select the operation method

As the method to perform the automatic operations in the Playback mode, there are 2 methods. They are "***Internal operation***" and "***External operation***".

6.1.1 Internal operation

This robot controller is set to "***Internal operation***" when shipping. In the case of the "Internal operation", the series of operation-related commands such as start, program selection and stop are all executed on the teach pendant. For further details on operation, refer to the Basic Operations Manual.

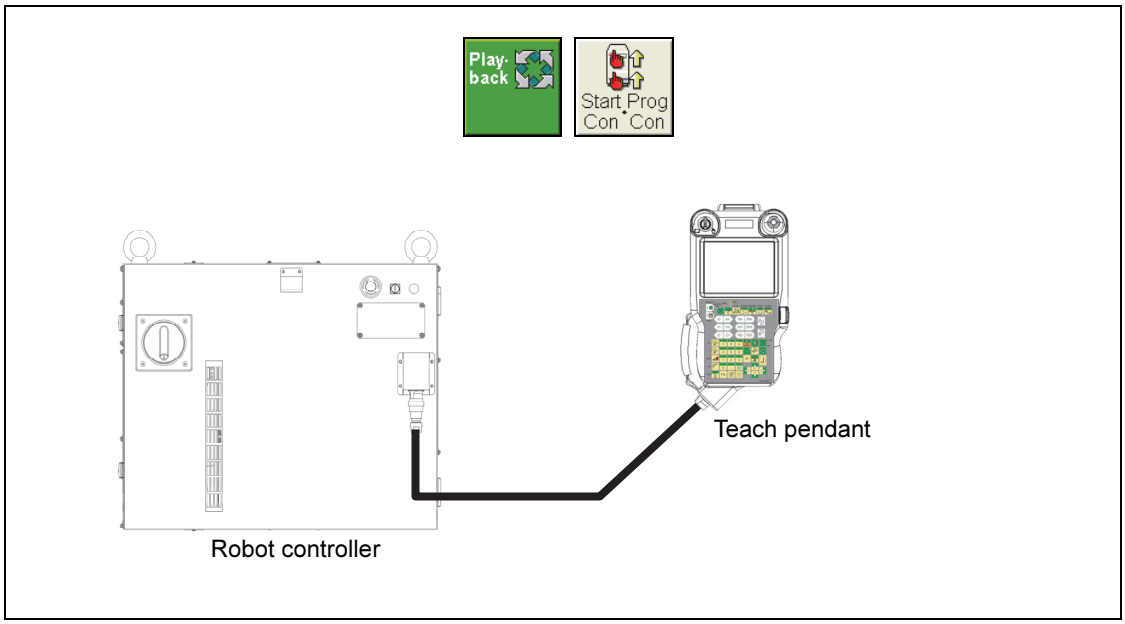
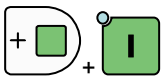
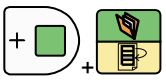
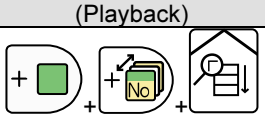
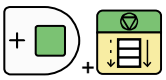


Fig. 6.1.1 "Internal mode" ("Motors ON/START" = "Controller" and "Playback mode prog sel." = "Controller")

Operations used in the "Internal mode"

Name	Motors ON	Program selection	Program start (Playback)	Program stop
Teach pendant			 (NOTE 1)	

(NOTE 1) To execute the start operation using the teach pendant, it is necessary to enable the key operation in the following menu. <Constant Setting> - [7 f-keys] [11 Starting key]
(For this setting, the operator class of ***SPECIALIST*** is necessary.)

DANGER

When starting a work-program, pay enough attention. The starting operation must be done from the outside of the robot's motion range. If this is not kept, death or serious injury may happen by being caught or being pinched by the robot arm.

6.1.2 External operation

In case of the "***External operation***", the series of operation-related commands such as start, program selection and stop are all executed using the external input signals from a master controllers like a PLC or the external operation panels etc.

For further details on operation, refer to the Basic Operations Manual.

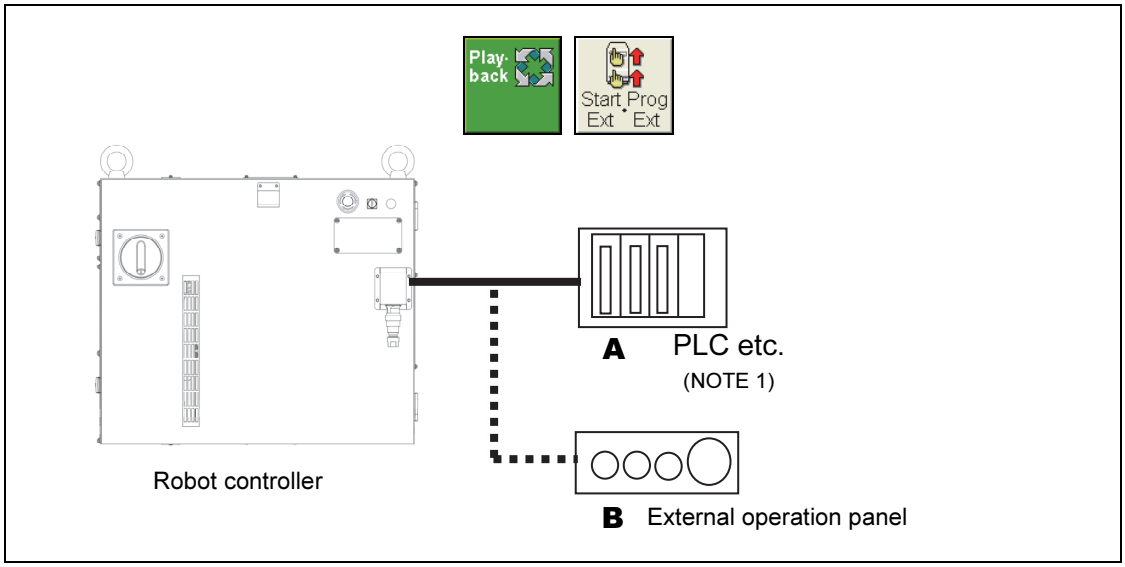


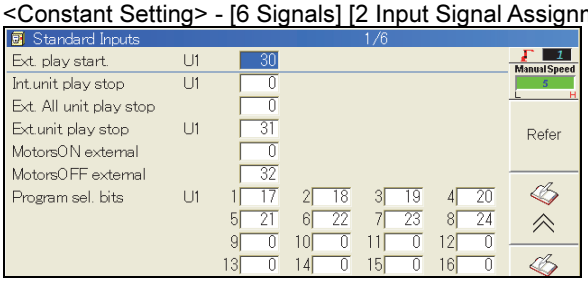
Fig. 6.1.2 "Internal mode" ("Motors ON/START" = "External" and "Playback mode prog sel." = "External")

Signal name	Description
"Ext. play start" (External playback start) (Factory setting : I30)	- When this signal turns ON, the program will start. - The width of this signal should be 200ms or more. - This signal can be used only when the "Motors ON/START sel. source" is "External".
"Ext. unit play stop" (External unit playback stop) (Factory setting : I31)	- While this signal is ON, the start operation is allowed. - When this signal turns OFF, the robot will stop. - This signal can be used in spite of the setting of "Motors ON/START sel. source".
"Motors ON external" (Factory setting : none)	- When this signal turns ON, the motor power source circuit will turn ON. - This signal can be used only when the "Motors ON/START sel. source" is "External".
"Motors OFF external" (Factory setting : I32)	- When this signal turns ON, the Motors power circuit will turn OFF. - This signal can be used in spite of the setting of "Motors ON/START sel. source".
"Program sel. bits" (Program selection bits) (Factory setting : I17 - I24) (8 bits)	- Please assign these signals depending on the number of the programs to be used. (When shipping, these signals can be used as 8 bits binary signals that can cover 0 to 255) - These signals can be used only when the "Playback mode prog. sel. U1" is "External".

POINT

The ***"Motors ON external"*** is not assigned to any signal number at the timing of shipping. To use this signal, please be sure to assign an input signal number in advance.

<Constant Setting> - [6 Signals] [2 Input Signal Assignment] [1 Standard Inputs]



(Factory setting)

(NOTE 1)
To input the external input signals from an external PLC etc. to this robot controller, the field-bus functions (e.g. DeviceNet, CC-LINK, etc.) or the I/O board are necessary.

Concerning the field-bus functions, refer to the respective option manuals.
Concerning the I/O board, refer to the chapter 3.
Concerning the details of the respective I/O signals, refer to the instruction manual “EXTERNAL INPUT/OUTPUT”.
Concerning the timing chart for the input signals, refer to p6-6.

(NOTE 2)
To connect an external emergency stop button, see the chapter 3 “Safety-related signal connections”

IMPORTANT

The external PLC or the external operation panel etc. should be prepared by customer.
The field bus functions like DeviceNet and the I/O board (DC24V I/O) are options.

CAUTION

Although it is possible to select only 1 from the “***Internal operation***” and the “**External operation**”, the stop operation and the emergency stop operation are available from anywhere and in any methods. For example, the work-program that is running in the “***Internal operation***” can be stopped not only by the stop button of the operation panel but also by the “*Ext unit play stop*” signal

Concerning the selecting operations for the “***Internal operation***” and the “***External operation***”, see the next pages.

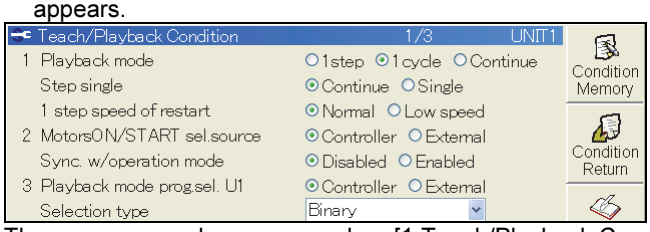
How to select the internal (=Controller) or external mode

There are 2 kinds of setting available.
1) "Motors ON/START selection source"
This is an input method for the motors ON signal and the work-program start signal
2) "Playback mode program selection"
This is the setting for the selection of the work-program number.

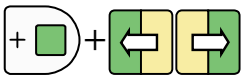
These items can be set independently. But, normally, set the same setting.

1 **Select Teach mode or Playback mode.**

2 **Press the <Teach/Play Condition> f key.**
>>The Teach/Playback Conditions setting screen such as the one shown below now appears.



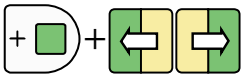
The same menu also appears when [1 Teach/Playback Condition] are selected from the <Service Utilities> f key.



3 **Align the cursor with "Motors ON/START sel. source," and press the [ENABLE] and left or right cursor keys to select the settings of the radio buttons (the horizontal rows of selector buttons).**

Motors ON/ START select	Description/Explanation
Controller	- The Motors can be turned ON using the [Motors ON] button. - Automatic operation can be initiated using the [START BUTTON]. (On the operation panel or the operation box) (The same operation can be done by using the teach pendant)
External	- The Motors can be turned ON using an external input signal. (*"MotorsON external"*) from an external device. (NOTE) - Automatic operation can be initiated by an external input signal (*"External play start."*) from an external device. A signal is assigned as a standard signal for the external start signal. (I30)

(NOTE) When shipping, the "MotorsON external" is not assigned to any signal number. To use this signal from external device (e.g. PLC), please assign this function to an external input signal in advance. (e.g. I29)



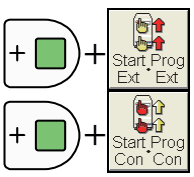
4 **In the same way, align the cursor with "Playback mode prog. sel.", and press the [ENABLE] and left or right cursor keys to select the settings of the radio buttons (the horizontal rows of selector buttons).**

Playback mode program select	Description/Explanation
Controller	Programs can be selected from the teach pendant.
External	Programs can be selected by input signals (external program selection signals) from an external device. A signal up to 8 bits is assigned as a standard signal for the external program select signal.

In the teach mode, programs cannot be selected using the external input signals.
"External" for program select is set only in the playback mode.

5 **Upon completion of the settings, press the <Complete> f key.**
The settings are saved in the file, and so their statuses are retained even when the power is turned off.

== Switching both signals simultaneously in a single action ==



6 **Press the [Start Ext·Prog Ext/Start Con·Prog Con] keys at the same time as the [ENABLE] key.**
>>Each time these keys are pressed, "Controller" or "External" for the motors ON/START select and program select signals is switched in synchronization.
This is useful when the motors ON/START select and program select settings are to be used in the same status.
When this key is used, there is no need to press the [Complete] key.

If the f key [Start Ext·Prog Ext/Start Con·Prog Con] has not been assigned, it can be assigned by selecting <Constant Setting> **-** [7 f-Keys] **-** [2–4 Soft Key Layout].

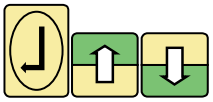
Specification of the external program selecting method

POINT

With "External" for the program select signal, the number of the program to be played back is determined by an input signal from the external source. There are several ways to read the program numbers. Read through the following, and proceed with operation using the settings tailored to the system.

1 On the same setting screen as the one mentioned above, align the cursor with "Selection type."

There are three ways to read the program select bits (16 signal lines): "binary," "discrete" and "BCD (Binary Coded Decimal)."



2 Press [ENTER] to select one of the methods as followed.

External program selection method	
Binary	With this method, the signals are read out as binary numbers. If, for instance, bits 3 and 5 are ON, program no.20 (2^2+2^4 = 4+16) will be selected.
Discrete	With this method, the number of the bit turned ON by the signal is used as the program number. This means that only programs with numbers from 1 to 16 can be selected. If two or programs are input at the same time, the one with the lower number is selected.
BCD (Binary Coded Decimal)	With this method, the signal is read out as a BCD code. If, for instance, bits 3 and 5 are ON, program no.14 will be selected since the 1's digit is 2^2=4 and the 10's digit is 2^1=1.

	Program select bit U1															
Signal	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Binary	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Discrete	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
BCD	1000's digit				100's digit				10's digit				1's digit			

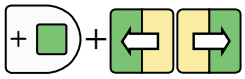
Signals 1 to 16 are the numbers of the 16 "Program sel. bits" input signals.

When "binary" or "BCD" is selected for the "selection system," a multiple number of signal lines are read so that the program strobe signal for determining their read timing is used. There is a special method that does not use the program strobe signal, as set forth below.

3 On the same setting screen as the one mentioned above, align the cursor with "Strobe signal."

There are two method: one uses the program strobe signal and the other ones don't

Strobe signal	Description/Explanation
Used	When the robot is to be started from an external source, maintain a pulse width of at least 0.2 sec. for the start signal. Input the strobe signal when at least 0.01 sec. has elapsed after the program select signal has stabilized. If the start status has already been established by this time, program selection is executed at this time. If the start status is not established, program selection is executed as soon as the start signal has been input. (Program selection range: 0 to 9999) (Note that even No.0 can be selected.)
Unused	When the robot is to be started from an external source, maintain a pulse width of at least 0.2 sec. for the start signal. At the point when no change has occurred for 0.10 sec. after the program select signal was input, the input signal is considered to be a definite signal, and it can be captured. If the start status has already been established by this time, program selection is executed. If the start status is not established, program selection is executed as soon as the start signal has been input. (Program selection range: 1 to 9999) (Note that No.0 cannot be selected.)

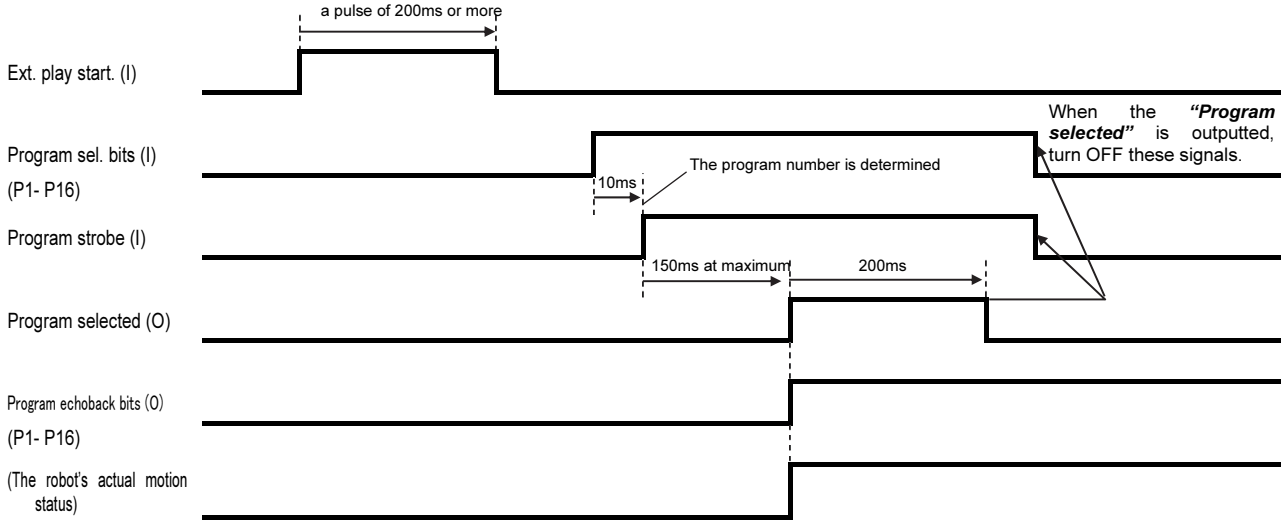


4 Press [ENABLE] and left or right cursor keys to select the settings of the radio buttons (the horizontal rows of selector buttons) and select one of these two methods.

5 Upon completion of the settings, press the <Complete> f key.

When using a strobe signal

■ In a case in which ***"Program strobe"*** is inputted after ***"Ext.play start"***
(Motors should be turned ON in advance by using the *"MotorsON external"* input signal.)

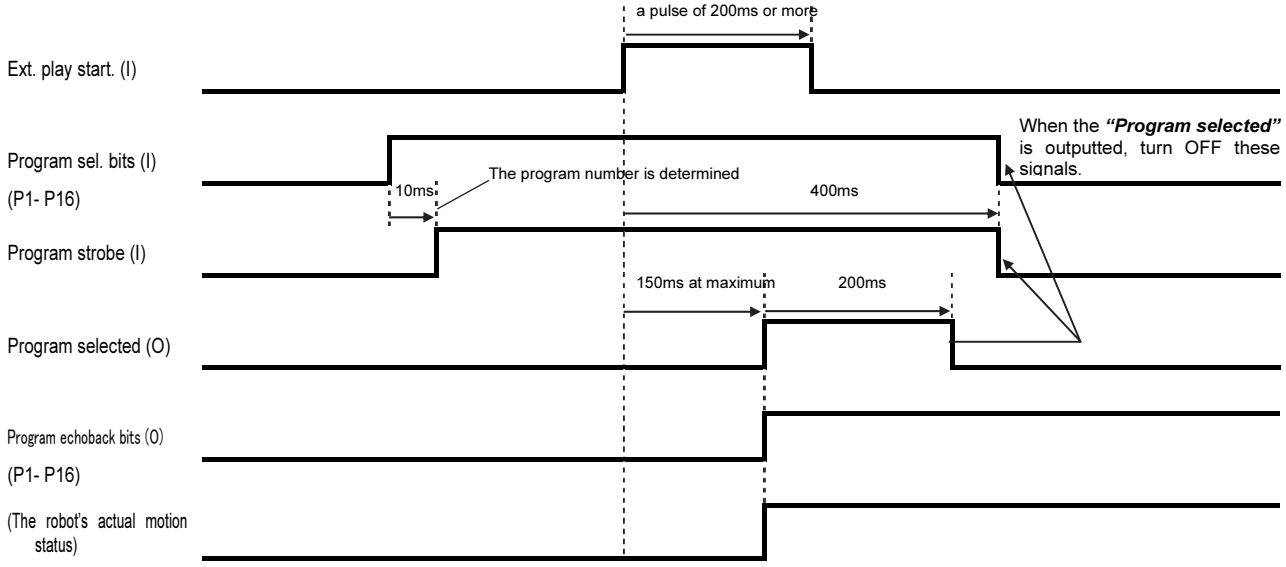


(I) : Input signal (From external device to robot controller / (O):Output (From robot controller to external device)

CAUTION

- ***"Ext. play start"*** signal should be a pulse signal of 200ms or more.
- ***"Program strobe"*** signal should be inputted after the ***"Program sel.bits"*** signals are inputted and all of those signals get stable and 10ms or more passed. If the ***"Program strobe"*** signal is inputted during the ***"Program sel.bits"*** are still unstable, an unexpected program number may be chosen.
- The pulse's width of the ***"Program selected"*** signal is 200ms at the factory(default) setting. But the width can be changed in the following setting menu.
  →<Constant Setting>[6 Signals][1 Signal condition][6 Program acknowledge time] (unit : sec)
- ***"Program selected"*** and ***"Program echoback bits"*** are outputted when the actually selected program starts.
- When the ***"Program selected"*** is outputted, turn OFF the ***"Program sel.bits"*** and the ***"Program selected"*** signals altogether.

■In a case in which ***"Program strobe"*** is inputted before ***"Ext.play start"***
(Motors should be turned ON in advance by using the *"MotorsON external"* input signal.)



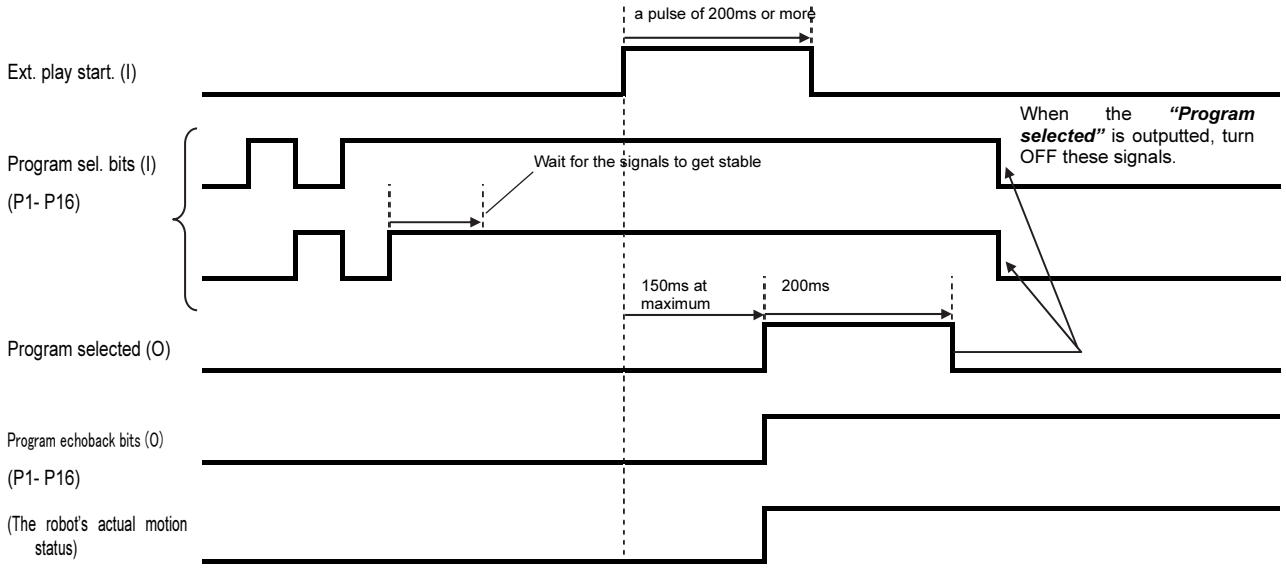
(I) : Input signal (From external device to robot controller) / (O):Output (From robot controller to external device)

CAUTION

- ***"Ext. play start"*** signal should be a pulse signal of 200ms or more.
- ***"Program strobe"*** signal should be inputted after the ***"Program sel.bits"*** signals are inputted and all of those signals get stable and 10ms or more passed. If the ***"Program strobe"*** signal is inputted during the ***"Program sel.bits"*** are still unstable, an unexpected program number may be chosen.
- The pulse's width of the ***"Program selected"*** signal is 200ms at the factory (default) setting. But the width can be changed in the following setting menu.
  →<Constant Setting>[6 Signals][1 Signal condition][6 Program acknowledge time] (unit : sec)
- ***"Program selected"*** and ***"Program echoback bits"*** are outputted when the actually selected program starts.
- When the ***"Program selected"*** is outputted, turn OFF the ***"Program sel.bits"*** and the ***"Program selected"*** signals altogether.

When not using a strobe signal

Input the ***"Ext. play start"*** signal after the combination of ***"Program sel.bits"*** gets sufficiently stable (100 msec or more). In this case, the ***"Ext. play start"*** signal plays a role of ***"Program strobe"*** signal at the same time.
(Motors should be turned ON in advance by using the *"MotorsON external"* input signal.)



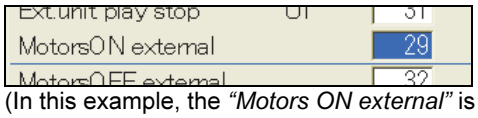
(I) : Input signal (From external device to robot controller / (O):Output (From robot controller to external device)

CAUTION

(NOTE 1) ***"Ext. play start"*** signal should be a pulse signal of 200ms or more.
(NOTE 2) The pulse's width of the ***"Program selected"*** signal is 200ms at the factory (default) setting.
But the width can be changed in the following setting menu.
→<Constant Setting>[6 Signals][1 Signal condition][6 Program acknowledge time] (unit : sec)
(NOTE 3) ***"Program selected"*** and ***"Program echoback bits"*** are outputted when the actually selected program starts.
(NOTE 4) When the ***"Program selected"*** is outputted, turn OFF the ***"Program sel.bits"***.

6.1.3 "Motors ON external" signal assignment

In the FD controller, the *"Motors ON external"* signal is not included in the terminal block in the controller. So if you want to turn the Motors ON using the external PLC etc., it is necessary to assign a general input signal to the *"Motors ON external"* in advance. See "4.6.2 Standard input signals" also.



(In this example, the *"Motors ON external"* is assigned to the input signal 29.)

This *"Motors ON external"* input signal can be assigned in the menu of
<Constant Setting> - [6 Signals] [2 Input Signal Assignment] [1 Standard Inputs].

And also, require to set <Service>-[1 Teaching /Playback conditions]–Set the "MotorON Select" to "External" to use this signal. Please refer to "6.1.2 External operation"

6.2 Home position registration

When a multiple number of robots are to be started up together from the host controller unless start is instructed after it has been verified that the robots are at their prescribed positions (home positions), they may, in a worst case scenario, interfere with one another.
To solve this problem, whether the robots are at their prescribed positions can be verified by means of an output signal by registering the home positions of the robots.
In checking the home positions, the positions of each robot axis are directly monitored so that the operator can know for sure that a robot is at its home position by the output signal.

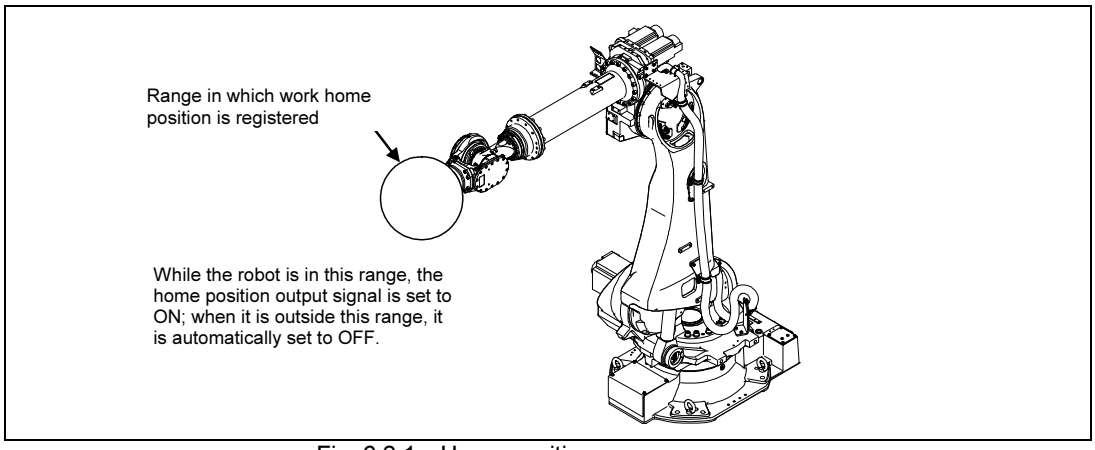


Fig. 6.2.1 Home position

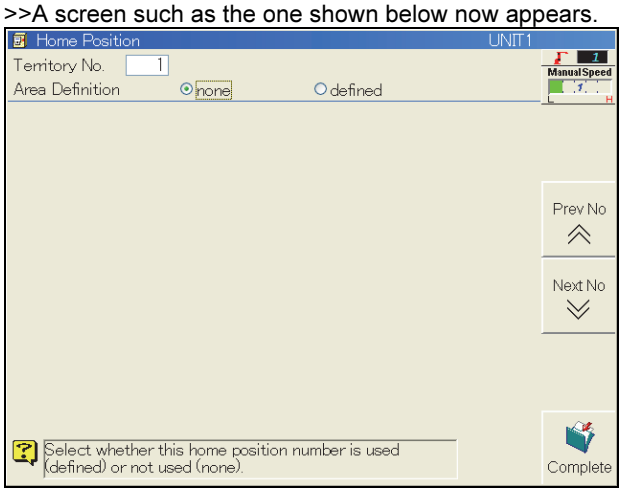
Up to 32 home positions can be registered per unit (the unit in which the task program is configured).
Some methods are provided for registering. First, the usual registration method is described.

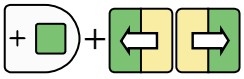
6.2.1 Home position registration by referencing the program

1 **First, teach the position that is to serve as the home position using the robot.**
Select any program, and record the actual position as a step.
Any interpolation type, speed or tool number is acceptable.
>>Normally, this step should be the first step (move command) in the program which is to be started from the work home position. Any program and any step with any number will do. Make a note of them.

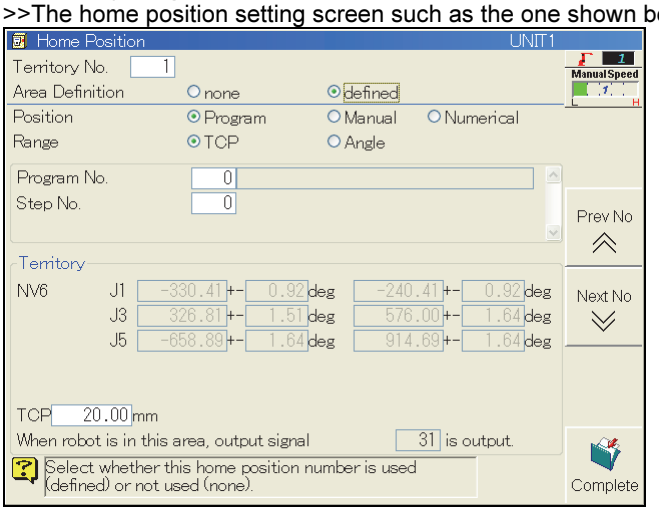
2 **Select the teach mode.**

3 **Select <Constant Setting> - [9 Territory Definition] - [1 Home Position].**
>>A screen such as the one shown below now appears.

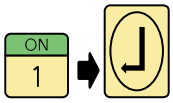




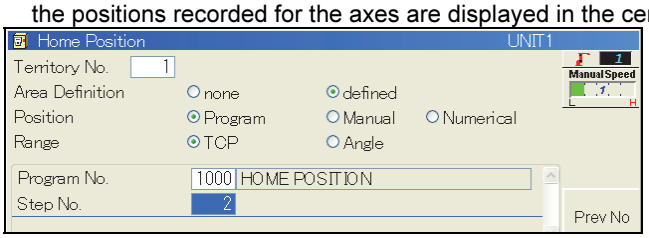
4 **Align the cursor with "Area Definition," and press [ENABLE] and left or right cursor keys together to set the radio button to "Defined."**
>>The home position setting screen such as the one shown below now appears.



5 **Leave the "Position" setting as "Program" and the "Range" setting as "TCP."**



6 **Align the cursor with "Program No.," input the number of the program prepared in 1, and press [Enter] key.**
In the same way, align the cursor with "Step No.," input the step number, and press [Enter] key. A step No. indicating a move command—not a comment or other function command—must be input without fail.
>>The data recorded in the program and steps which were input is now called, and the positions recorded for the axes are displayed in the center.

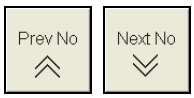


7 **Align the cursor with "TCP," input the home position range here, and press [Enter] key. The diameter of a spherical shape that can be visualized is input here. The home position signal is output when the tool tip is inside this spherical shape.**
Normally, about 20 mm is recommended.
>>The size of the spherical shape is broken down into the angles of the axes, and a range is now displayed at the positions recorded for the axes in the center.

8 **Press the <Complete> f key.**
This now completes the settings.

If the position of the program and step which were input in 6 has been modified or if unfinished steps have been deleted or inserted at any point after this, the setting for the step number of the home position will be automatically updated in tandem with this change.
By having the step in the registered program serve as the first step in the program which is started, no further attention need be paid to the home position registration even when the position in that step has been modified by teaching after home position registration.
(However, in the event that the registered step itself has been deleted, the home position registration will be deleted linked with this deletion.)

Registering a multiple number of work home positions

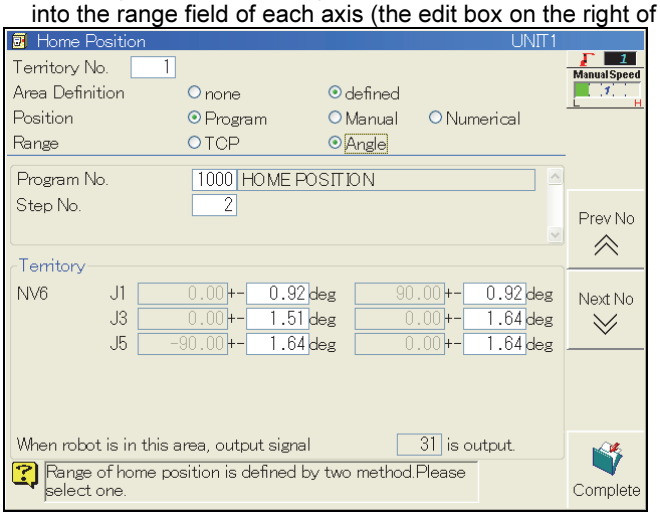


9 **A multiple number of home positions can be recorded. (Up to 32 positions per unit) To switch the screen, press [Prev No] or [Next No] key.**
Alternatively, align the cursor with the "Territory No." in the edit box, input the home position number directly, and press [Enter] key.

Basic output signal is allocated to only “Territory No.1” when shipped. To use No.2 and up, basic output signals must be allocated for each of it.
Output signal number currently assigned is displayed at the bottom of the screen.

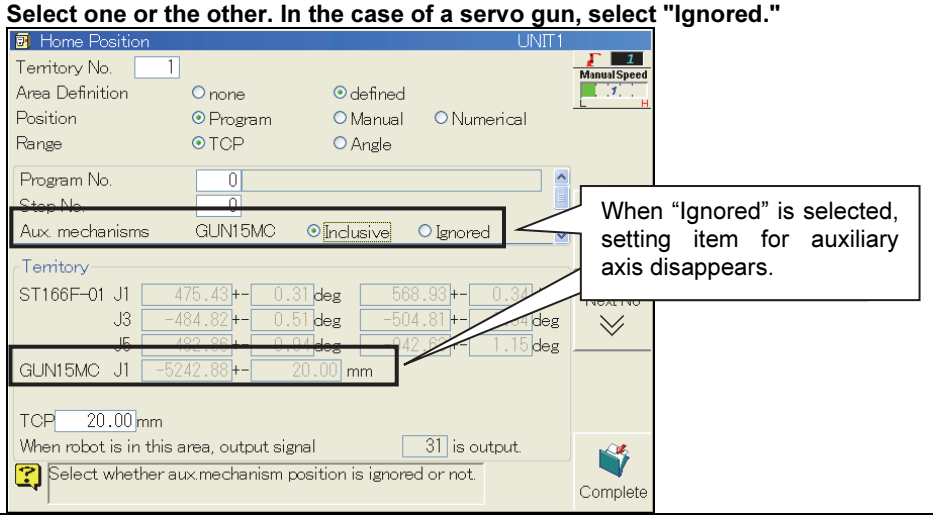
Specifying the range on an axis by axis basis

10 **The range of the home position can be specified directly for each of the axes. Set "Range" to "Angle" rather than to "TCP."**
>>The range input field changes as shown below. Input the range directly in degrees into the range field of each axis (the edit box on the right of + –).



When auxiliary mechanisms are present

11 **If an auxiliary mechanism such as servo gun or travel unit is being used, "Aux. mechanisms," which is a new item, is displayed. Depending on the characteristics of the mechanism concerned, the home position may or may not be monitored.**
Select one or the other. In the case of a servo gun, select "Ignored."



CAUTION

While executing the ***"Mechanism disconnection"*** function, the concerned (disconnected) mechanism's position is not checked. It is regarded that the position is in its (registered) HOME position always. In addition, if the all mechanisms of a UNIT are disconnected, the signal of ***"Home position"*** is always ON. Therefore, in a case of a system that checks the ***"Home position"*** signal in the production start sequence, if there exists a mechanism that is executing the mechanism disconnection function, there may be a possibility that the start operation is allowed from a position that is not intended. In a case like this, it is recommended to check the signal of ***"Mech.Disconnection"*** also to avoid unexpected accidents.

<Example of HOME POSITION registration>
Robot itself = (0, 120, -30, 0, 0, 0) / traverse unit = (0)
Aux. mechanism = "Inclusive"

Example1
Robot itself : Connected and in the HOME position (0, 120, -30, 0, 0, 0)
Traverse unit : **Disconnected** and out of the HOME position (-100)
"HOME position" signal is **ON**

Example2
Robot itself : **Disconnected** and out of the HOME position (0, 90, 0, 0, 0, 0)
Traverse unit : Connected and in the HOME position (0)
"HOME position" signal is **ON**

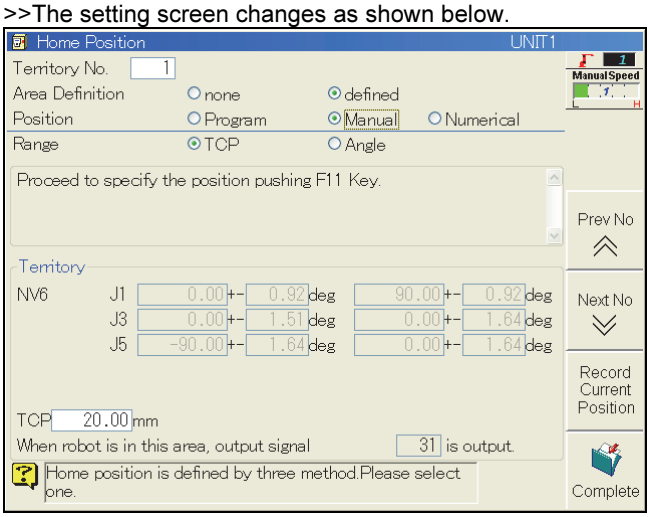
6.2.2 Home position registration by manual recording

This method is used to record the home position directly without referencing the program. Operate the robot to set it.

The home position registration is not changed linked with any modifications made by teaching, and the absolute position is now registered. Unlike the program reference system, programs need not be provided ahead of time.

Only the differences from the program reference system will be described below.

1 **Set "Position" to "Manual."**
>>The setting screen changes as shown below.



2 **Turn on the motor power (servo power), and move the robot by manual operations to the position which is to serve as the home position. Once the position has been determined, release the enable switch. (Alternatively, turn off the motor power.)**

Record Current Position

3 **Press the <Current Record Posi.> f key.**
>>The current position is read from the robot encoder, and the position data of each axis is displayed in the center.

4 **Set the "TCP" in the same way as with referencing the program. (The next steps are the same.)**

6.2.3 Home position registration by numeric input

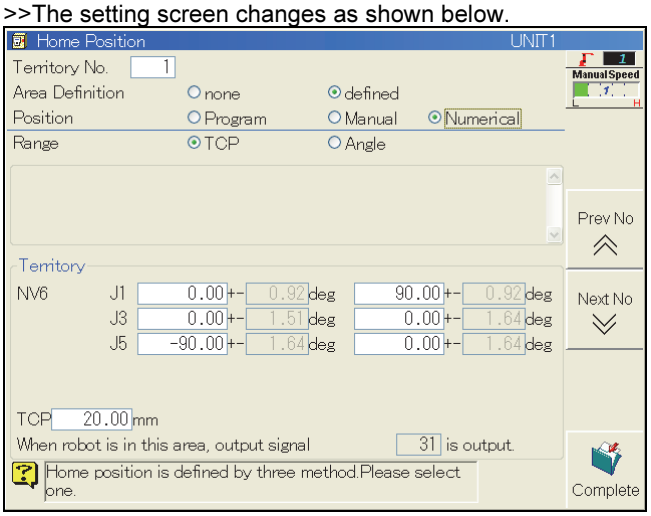
This method is used to record the home position directly without referencing the program. Key in the position data directly from the teach pendant.

The home position registration is not changed linked with any modifications made by teaching, and the absolute position is now registered. Unlike the program reference system, programs need not be provided ahead of time.

Only the differences from the program reference system will be described below.

1 **Set "Position" to "Numerical."**

>>The setting screen changes as shown below.



2 **Move the cursor to the "Territory" field, input the position of each of the axes directly in degrees, and press the [Enter] key.**

>>It is possible to input positions that significantly exceed the software limits (operating ranges) of the axes. Some axes which have been excluded from being the target of inspection for their home positions can be supported by setting a high value.

The same result can be achieved by proceeding as follows: after "Position" has been set to "Program," the program and step have been specified and the position data has been read, switch the "Position" setting to "Numerical," and modify the position of each axis.

3 **Set the "TCP" in the same way as with referencing the program. (The next steps are the same.)**

6.3 Registering Start Enable Area

This function enables to register the safe position to start the robot (Start enable area), which restricts the start if the robot is not within the specified area. The difference from the home position registration system is that robot controller itself can confine the robot start.

IMPORTANT

To restrict the robot start by robot controller using the Start enable area, the setting for “Start enable area” shall be specified as the condition of “Unit READY” in the section 6.4.2 Unit READY signal.

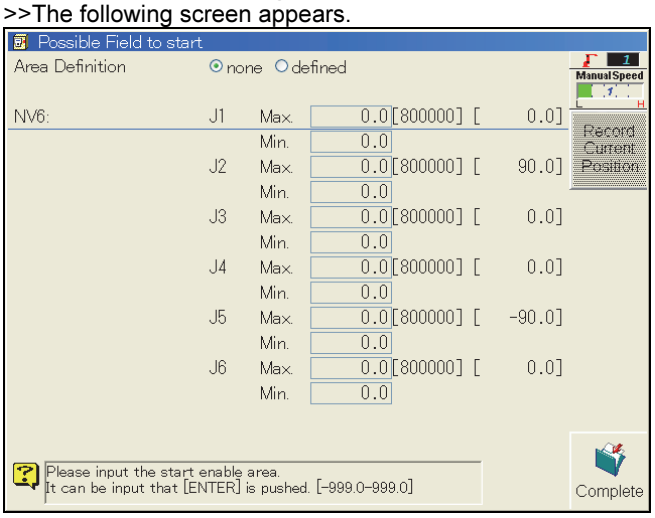
The start enable area can be registered to the mechanism one to one. When all the mechanisms included in a unit are in the registered area, the unit is considered within the range of start enable area. For the management unit, all the mechanisms in a system are to be checked.

6.3.1 Registering the start enable area

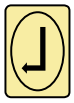
Note that the operator class of ***EXPERT*** or higher is required for this operation.

1 Select the teach mode.

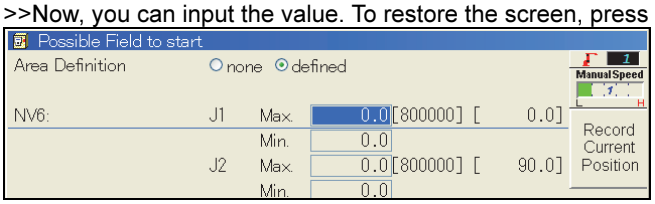
2 Select <Constant Setting> - [9 Area] – [3 Possible Field to start].
>>The following screen appears.

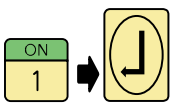


3 Align the cursor with “Area Definition” and press [Enable] + [Right/Left] key at a time to move the radio button to “defined”.

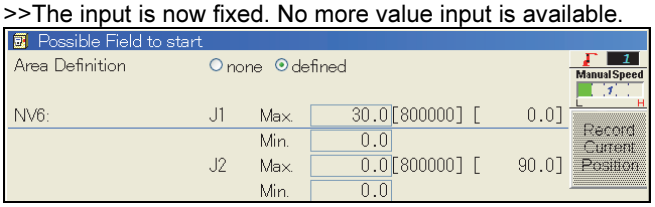


4 Move to the axis to set the area, and press [Enter] key.
>>Now, you can input the value. To restore the screen, press [Enter] key again.



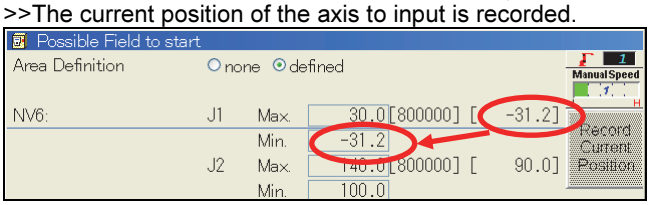


5 When the value input is available, enter the area to set and press [Enter] key.
>>The input is now fixed. No more value input is available.

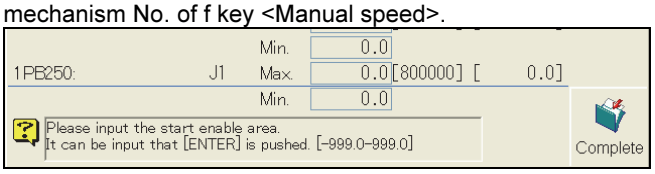


For the rotation axis, specify the area within the range of -999.0 ˚ − 999.0 ˚. For the slide axis, -9999.9mm − 9999.9mm.
The axis, of which both "Max." and "Min." have been set at 0.0, is not to be checked whether it is in the start enable area or not.

6 **When the value input is available, press f key <Record Current Position>.**
>>The current position of the axis to input is recorded.



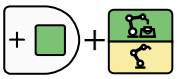
7 **Press [UNIT/MECHANISM] key to move to the next mechanism.**
>>The cursor moves to the first axis of the following mechanism, renewing the mechanism No. of f key <Manual speed>.



8 **After inputting the start enable area, press f key <Complete>.**
Thus, the setting is complete.

6.3.2 Checking the unit if it is in the start enable area

This section describes how to check if the unit is in the start enable area.



1 **Switch the unit that checks if the robot is in the start enable area to the current unit by pressing [Enable] + [UNIT/MECHANISM] key.**

2 **When the current unit is within the start enable area, the following icon appears in the "Variable status display area".**

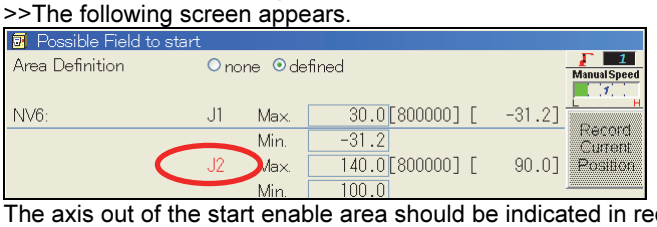
If not, this icon does not appear.

6.3.3 Checking which axis is out of the start enable area

When the current unit is out of the start enable area, it is enabled to check which axis is out of the range.
There is no requirement on the operator qualification to perform this operation.

1 **Select the teach mode.**

2 **Select <Constant Setting> - [9 Area] - [3 Possible Field to start]].**
>>The following screen appears.



The axis out of the start enable area should be indicated in red.
On the other hand, the mechanism not included in the current unit should not be indicated in red even if out of the area.

6.4 READY status output signals

If the robot is to be started from an external source, it is necessary to check beforehand whether the robot is actually in a status in which it can be started. This job is done by the controller READY signal, Unit READY signal, and status output signal.
Ensure that these output signals are used by the host controller as conditions of the start command for the robot.

6.4.1 Controller READY signals

This level signal is output after the power has been turned on when the operating system (Windows) and the robot software have started up in sequence and normal control is exercised. It is only when this signal has been output that the status in which I/O (Input/Output) control is enabled is established.

This signal has been assigned as a standard signal as one of the basic output signals.

Once this signal is turned ON, this signal is never turned OFF until the controller power is turned OFF.

6.4.2 Unit READY signal

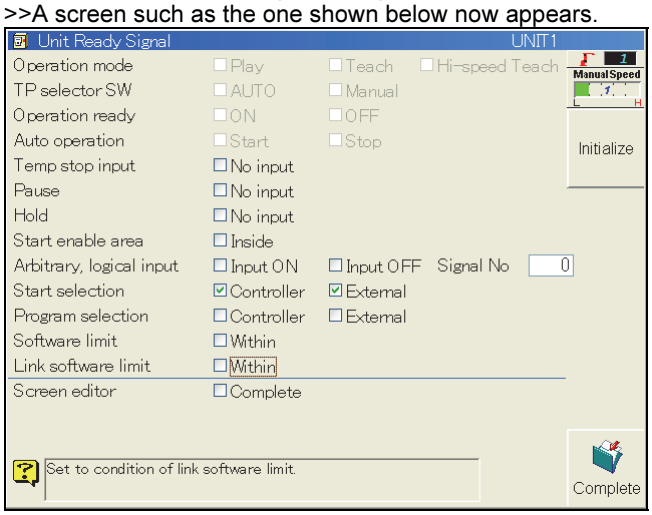
This level signal is output in a status in which the auto operation (starting in playback mode) is acknowledged. The robot cannot be started unless the conditions are met. (This controller itself will not accept start.) This signal has been assigned as a standard signal to serve as one of the basic output signals.

The signal can be set using a combination of several conditions. Generate the "unit READY" signal by combining each of the conditions in the sequence below.

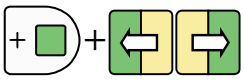
Generating the unit READY signal

1 **Select the teach mode.**

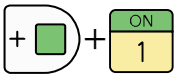
2 **Select <Constant Setting> - [6 Signal attributes] - [4 Unit Ready Signal].**
>>A screen such as the one shown below now appears.



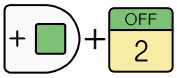
The unit READY signal turns ON only when each of the conditions listed vertically has been met. It remains OFF when even one condition has not been met.



3 **Align the cursor with the item to be set.**
The check box can be moved by pressing the [ENABLE] and left or right cursor keys.



4 **Align the cursor with the item serving as the ON condition of the output signal, and press [ENABLE] + [ON] keys.**
>>This will place a check mark in the box.



If the item is not going to serve as an ON condition, press [ENABLE] + [OFF] keys.
>>This will remove the check mark from the box. It is acceptable to place more than one check mark inside a horizontal row of boxes. It is also acceptable for no check marks to be placed inside the boxes.

(No changes can be made in those boxes which have been set to the disable status. Only a display appears in these boxes.)

In the following case, for example, the condition can be formed when the start selection is set to “Controller” or “External”. If putting multiple checkmarks in a single horizontal row like below, these items can be combined with the OR condition.

Start selection	☑ Controller	☑ External

With no checkmark, the condition will be independent of the output signal.
In the following example, the condition can be formed regardless of the start selection, whether “Controller”” or “External”.

Start selection	☐ Controller	☐ External

For the details of each condition, see “Table 6.4.1 Condition group used for Unit READY”.

5 **After all the items have been set, press the <Complete> f key.**
>>This has the immediate effect of setting the output signals ON or OFF.

6 **To clear all the check boxes at a time, press the <Initialize> f key.**
>>The check marks in all the check boxes of the status output signals currently displayed are now cleared.

Prior to shipment from the factory, there is no checkmark placed in any of the check boxes.
This means that the unit READY output signal is always ON by the initial setting.

As for the disabled (grayed-out) boxes;
Setting condition (ON/OFF) of these boxes will change when the items lower than “Temp stop input” are checked and f12 <Complete> key is pressed. To turn OFF the check marks, please use “Initialize” f-key.

Table 6.4.1 Condition group used for Unit READY

Item	Details	Unit READY
Operation mode	Playback: The condition is met when playback is set as the operation mode.	×
TP selector SW	AUTO: The condition is met when the teach pendant selector switch is set to auto.	×
Operation ready	ON: The condition is met when the motor power (servo power) is set to ON.	×
Auto operation	Stop: The condition is met when auto operation is not underway.	×
Temporary stop input	No input: The condition is met without any temporary stop input signal.	○
Pause	No input: The condition is met without any pause input signal.	○
Hold	No input: The condition is met without any hold input signal.	○
Start enable area	Within the area: The condition is met with the robot in the start enable area. However, it is unconditional in the following cases. ・When the start method is “Multi-station”. (1) At a temporary stop (2) The task program selected in the unit has been allocated as the start station and the current step is halfway with “Restart method in Play mode” set to “Specified”. ・When the start method is “Controller/External”. (1) At a temporary stop (2) The current step of the task program selected in the unit is halfway. The status “the current step is halfway” means that the current step is at the level of step excluding “0 [START]” and “END <FN92> function command with yellow color”.	○
Arbitrary logical input	Input ON: The condition is met when any designated logical input signal is set to ON. Input OFF: The condition is met when any designated logical input signal is set to OFF. However, it is unconditional during a temporary stop and also with the logical input signal of 0.	○
Start selection	Controller: The condition is met when motors ON/START selection is set to controller. External: The condition is met when motors ON/START selection is set to external.	○
Program selection	Controller: The condition is met when program selection is set to controller. External: The condition is met when program selection is set to external.	○

Item	Details	Unit READY
Soft Limit	Inside range: The condition is met when the soft limit has not been detected.	○
Link Soft Limit	Inside range: The condition is met when the link soft limit has not been detected.	○
Screen editor	Complete: The condition is met excluding during screen edit.	○

○ Can be set as the condition.
× Does not serve as a condition.

IMPORTANT

To specify the start enable area as a condition of the unit READY, see 6.3 Registering Start Enable Area and follow the procedures to register the start enable area.

6.4.3 Status output signals

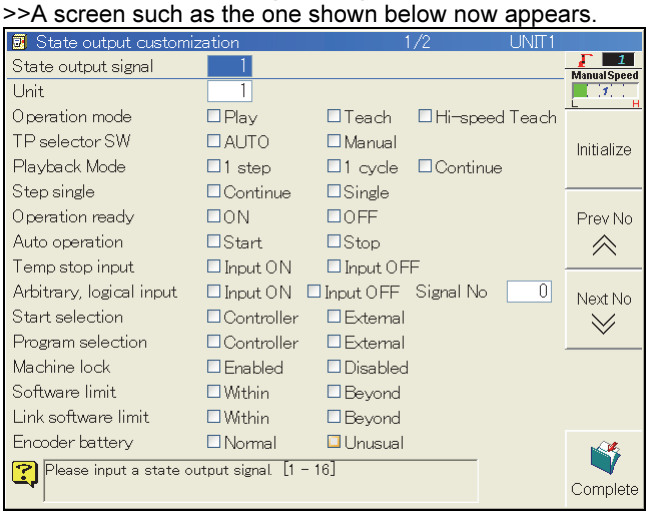
A signal known as a "status output" signal can be created by combining a number of statuses as desired. Unlike the unit READY output signal described above, controller itself will never fail to accept the start regardless of whether the "status output" signal is ON or OFF. A multiple number of "status output" signals can be defined, and the signal with the first condition among them has been assigned as a standard signal to serve as one of the basic output signals.

Follow the procedure below to create the "status output" signal by combining each of the conditions.

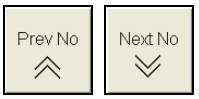
Generating a status output signal

1 Select the teach mode.

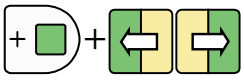
2 Select <Constant setting>-[6 Signal attributes] - [5 State output customization].
>>A screen such as the one shown below now appears.



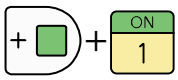
The status output signal turns ON only when each of the conditions listed vertically has been met. It remains OFF when even one condition has not been met.



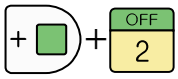
3 Press the [Prev No] or [Next No] f key or input a number in "Status output signal" at the very top of the screen, and press [Enter] key. This enables one of the 16 status output numbers provided to be selected.



4 Align the cursor with the item to be set.
The check box can be moved by pressing [ENABLE] and left or right cursor keys.



5 **Align the cursor with the item serving as the ON condition of the output signal, and press [ENABLE] + [ON] keys.**
>>This will place a check mark in the box.



If the item is not going to serve as an ON condition, press [ENABLE] + [OFF] keys.
>>This will remove the check mark from the box. It is acceptable to place more than one check mark inside a horizontal row of boxes. It is also acceptable for no check marks to be placed inside the boxes.

(No changes can be made in those boxes which have been set to the disable status. Only a display appears in these boxes.)
In the following case, for instance, the condition is met when the Playback mode is "1 cycle" or "Continuous." If, as in this case, a check mark has been placed in more than one box in a horizontal row, the settings are combined by an OR condition.

Playback Mode	☐1 step	☑1 cycle	☑Continue

Conversely, a case where none of the boxes has a check mark is handled in the same way as a case where check marks have been placed in all of the boxes. In the example given below, the condition is set whether the Playback mode is set to 1 step, 1 cycle or continuous, which means that it has nothing to do with the output signal.

Playback Mode	☐1 step	☐1 cycle	☐Continue

For the details of each condition, see “Table 6.4.2 Condition group used for the status output”.

6 **After all the items have been set, press the <Complete> f key.**
>>This has the immediate effect of setting the output signals ON or OFF.

7 **To clear all the check boxes together, press the <Initialize> f key.**
>>The check marks in all the check boxes of the status output signals currently displayed are now cleared.

Prior to shipment from the factory, no check marks were placed in any of the check boxes.
This means that the status output signal is always ON with the initial setting.

Table 6.4.2 Condition group used for the status output

Item	Details
Unit	This specifies the number of the unit that serves as a condition. (1 to 9) Either the same unit or various different units can be specified for all 16 status output signals. With a single unit, only one signal is involved so no attention need be paid to this operation.
Operation mode	Playback: The condition is met when playback is set as the operation mode. Teach: The condition is met when teach is set as the operation mode. High-speed teach: The condition is met when high-speed teach is set as the operation mode (option).
TP selector SW	Normally, do not place a check mark for either mode. AUTO: The condition is met when the teach pendant selector switch is set to auto. Manual: The condition is met when the teach pendant selector switch is set to manual.
Playback Mode	1 step: The condition is met when the operating mode is set to single step. 1 cycle: The condition is met when the operating mode is set to single cycle. Continue: The condition is met when the operating mode is set to continuous.
Step single	Continue: The condition is met when step feed is set to continuous. Single: The condition is met when step feed is set to single.
Operation ready	ON: The condition is met when the motor power (servo power) is set to ON. OFF: The condition is met when the motor power (servo power) is set to OFF.
Auto operation	Start: The condition is met when auto operation is underway. Stop: The condition is met when auto operation is not underway.
Temporary stop input	Input ON: The condition is met when the stop input signal is set to ON. Input OFF: The condition is met when the temporary stop input signal is set to OFF.

Item	Details
Arbitrary logical input	Input ON: The condition is met when any designated logical input signal is set to ON. Input OFF: The condition is met when any designated logical input signal is set to OFF.
Start selection	Controller: The condition is met when motors ON/START selection is set to controller. External: The condition is met when motors ON/START selection is set to external.
Program selection	Controller: The condition is met when program selection is set to controller. External: The condition is met when program selection is set to external.
Machine lock	Enabled: The condition is met while machine lock is established. Disabled: The condition is met while machine lock is not established.
Soft Limit	Inside range: The condition is met when the soft limit has not been detected. Outside range: The condition is met when the soft limit is being detected.
Link Soft Limit	Inside range: The condition is met when the link soft limit has not been detected. Outside range: The condition is met when the link soft limit is being detected.
Encoder battery	Normal: The status is established when no fault in the encoder battery is detected. Unusual: The condition is met when fault has occurred in the encoder battery.
Spot weld	Weld ON: The condition is met when spot welding is set to pressure ON. Weld OFF: The condition is met when spot welding is set to pressure ON. No SQZ: The condition is met when spot welding is set to pressure OFF.
User level	***USER*** or below: The condition is met when the current operator class is ***USER*** or below. ***EXPERT*** or above: The condition is met when the current operator class is ***EXPERT*** or above.
Playback speed override	Less than 100%: The condition is met when the speed override ratio is lower than 100%. 100%: The condition is met only when the speed override ratio is 100%. Excess of 100%: The condition is met when the speed override ratio is higher than 100%.
Mechanism servo OFF	ON: The condition is met when there is at least one mechanism of the individual mechanism OFF. OFF: The condition is met when there is no mechanism of the individual mechanism OFF.

6.5 Interference Territory registration

In case that robot operating envelop overlaps with another robot because they are installed so closely, robot will collide each other when they run into the overlapping area at the same time. This trouble can be avoided by using I/O interlocking signals. In advance, overlapping area (= Interference territory) must be defined in each robot (controller).

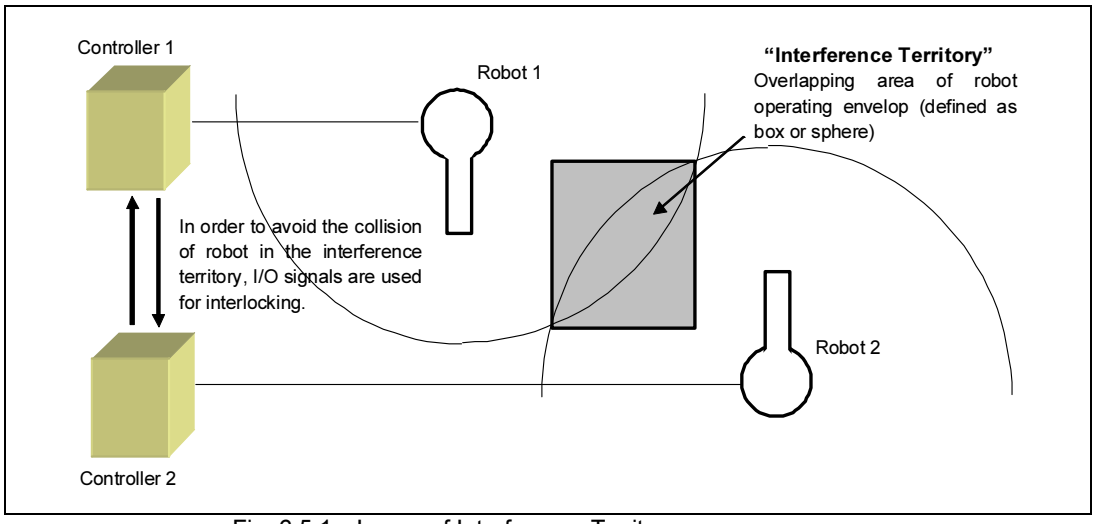


Fig. 6.5.1 Image of Interference Territory

Up to 16 interference territories can be registered per unit (the unit in which the program is configured).

IMPORTANT

Input/output signals for interference territory are not allocated when shipped.
If this utility is necessary, these signals must be allocated by referring to "4.6 Signal attribute settings".

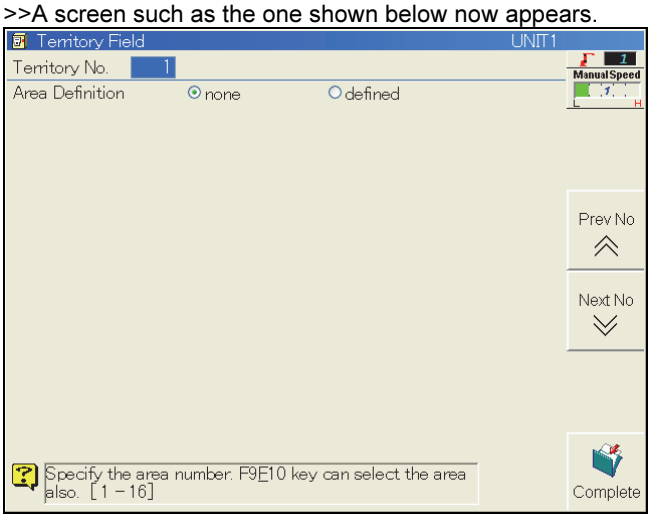
6.5.1 Registering the interference Territory

1 **First, teach the position that is the "center" of interference territory using the robot. Select any program, and record the actual position as a step.**

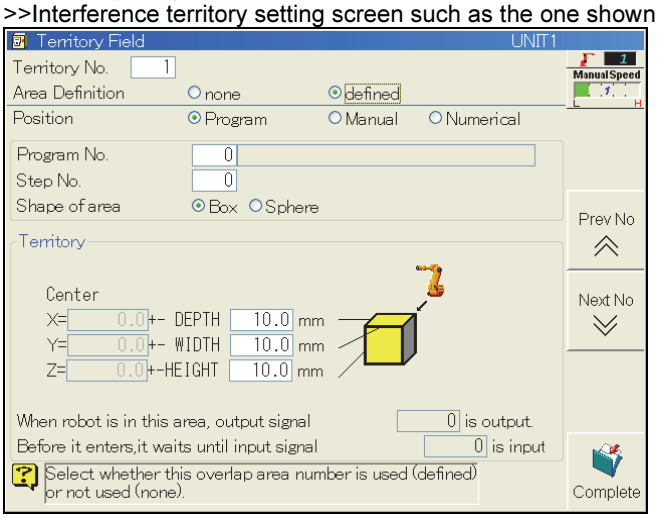
2 **Select the teach mode.**

Constant Setting

3 **Select <Constant Setting> - [9 Territory Definition] - [2 Territory Field].**
>>A screen such as the one shown below now appears.

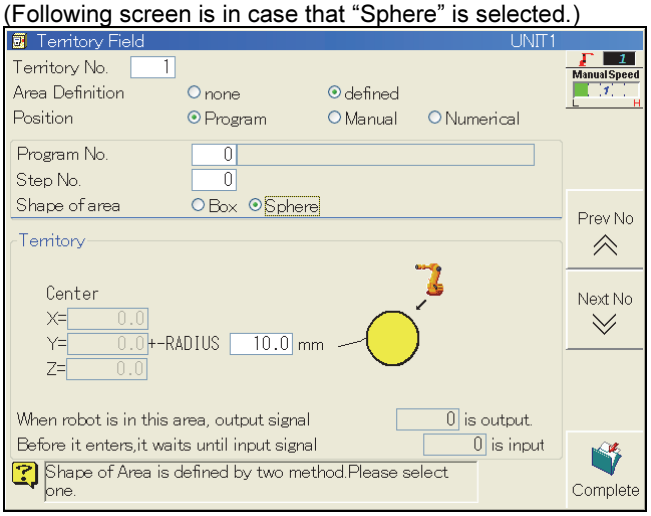


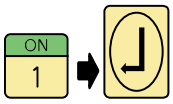
4 **Align the cursor with "Area Definition," and press the [ENABLE] and left or right cursor keys together to set the radio button to "Defined."**
>>Interference territory setting screen such as the one shown below now appears.



5 **Leave the "Position" setting as "Program".**

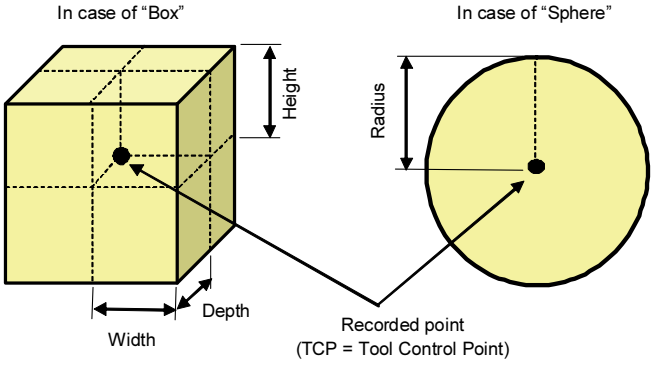
6 **Select either of “Box” or “Sphere” setting as “Shape of area”.**
(Following screen is in case that “Sphere” is selected.)



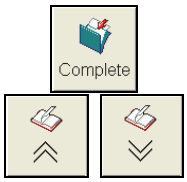


7 **Align the cursor with "Program No.," and “Step No.”, then input the number of the program and step No. prepared in 1, and press the [Enter] key.**
This step must indicate a move command without fail.
>>The data recorded in the program and step is now called, and its XYZ position data are displayed in the “Center” position.

8 **To define the size of interference territory, align the cursor to “Depth”, ”Width” and “Height” in case of “BOX”, or align to “radius” in case of “Sphere”. Input each length and press the [Enter] key**



Definition of Interference Territory

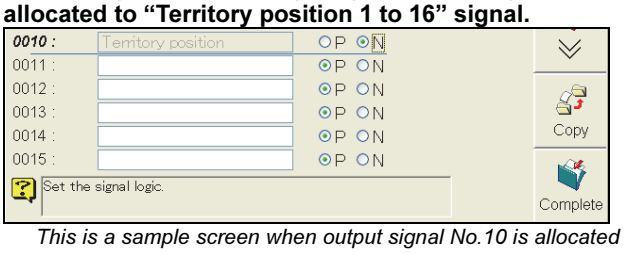


9 **Press the <Complete> f key.**
This now completes the settings.

10 **If plural interference territories need to be defined, switch the screen by pressing [Prev No] or [Next No] key and continue the registration procedure.**

11 **Next, following I/O signals for all interference area need to be allocated.**
Basic input signal "Territory position 1 to 16"
Basic output signal "Territory position 1 to 16"
"4.6 Signal attribute settings"

Furthermore, it is strongly recommended that logic of above output signal is changed to "N". Select <Constant Setting> - [6 Signals] - [7 Signal Attribute] - [2 Output Signal], and change logic to "N" (negative) of the output signal which is allocated to "Territory position 1 to 16" signal.

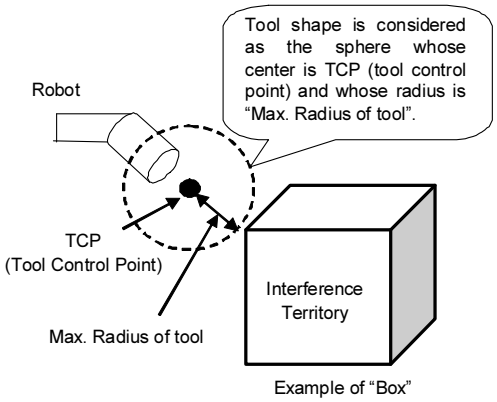


This is a sample screen when output signal No.10 is allocated to "Interference area".

When robot is outside the interference territory, "interference area output signal" is ON. And before robot is getting into the interference territory, robot waits for "interference area input signal" ON.

12 **Next, "Max. radius of tool" parameter needs to be defined.**
"4.5.6 Max. Radius of tool"

When checking the interference between the robot (tool) and interference territory, tool shape is considered as the sphere whose center is TCP (tool control point) and whose radius is "Max. Radius of tool". If tool scale is not to be ignored, please define its size.



14 **Similar setting is necessary to the other robot that has same interference territory.**

In case that "Position" is set to except "Program" in step 5

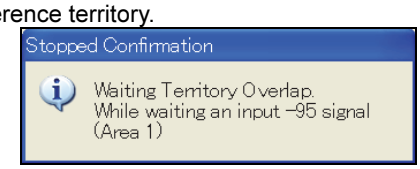
7 **When set to "Manual" :**
Move the robot by manual operation to the center position of interference territory, and press f11 < Record Current Position. > key.
Current position is read from the robot encoder, and the position data is displayed in the center.

When set to "Numerical" :
Directly input the XYZ value in "Center" of interference territory.

6.5.2 Utilizing the Interference Territory

Special function is unnecessary to be recorded to check the interference of robot.
While the check GO/BACK operation and playback operation, interference checking is automatically performed by following procedure when robot is getting into the interference territory. (In following description, R#1 means the subject robot and R#2 means the opposite robot that has same interference territory with R#1.)
Here, “Territory position output signal” which is allocated by the pre-described procedure is directly connected to “Territory position input signal” of the opposite robot without changing its logic.

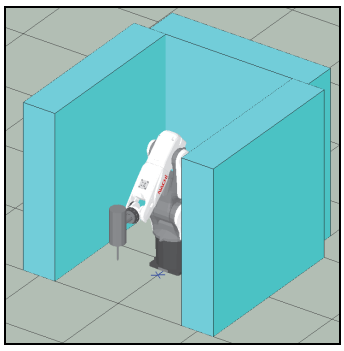
(1) Immediately before R#1 gets into the interference territory, R#1 checks “Territory position input signal” from R#2.
(2) If “Territory position input signal” was ON, R#1 turns OFF the “Territory position output signal” and gets into the interference territory because R#2 is outside the interference territory.
(3) If “Territory position input signal” was OFF (this means R#2 is still in the interference territory), R#1 starts waiting until R#2 goes out of the interference territory and “Territory position input signal” is turned ON,. While waiting, right message will be displayed.

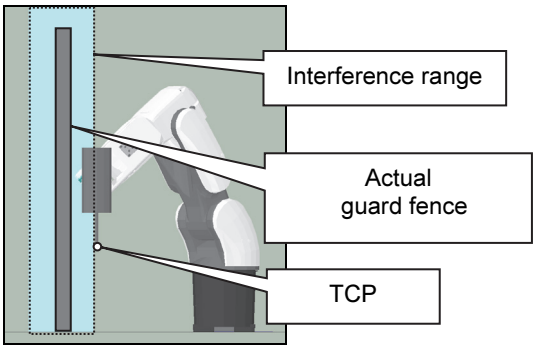


(4) After R#2 goes out of the interference territory and “Territory position input signal” is turned ON, R#1 turns OFF the “Territory position output signal” and gets into the interference territory.
(5) When R#1 goes out of the interference territory, “Territory position output signal” is turned ON.

6.5.3 Application example of “Interference range” setting

For instance, it can reduce the possibilities of interference due to operation mistake by surrounding robot with multiple rectangular interference range as below.（All Input signals, which is assigned to each interference range should be OFF.）Size of the interference range must be set slightly larger than the actual protection fence for ensuring margin.

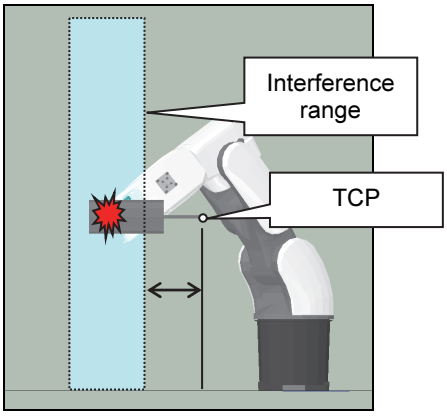




However, this is simple setting, so it is necessary to pay attention to points below.

(1) It doesn’t’ mean changing “limit range”. For changing limit range of the robot, it is necessary to take a measure of mechanical stopper and so on.

(2) Shapes of Arm and hand are not considered. Monitoring is done based on TCP coordinate. Therefore, the arm can interfere to the interference range with the posture as below.



Chapter 7 Connection to Ethernet

This chapter describes how to use FTP (File Transfer Protocol) which is performed between the robot controller and the other nodes (such as PC) on the network using the Ethernet function.

7.1 Outline

7.1.1 Outline

To use the Ethernet function enables various files to be transferred between this controller and the other nodes (such as PC) on the network using FTP (File Transfer Protocol). Data such as constant files, PLC program files, task program files etc. are stored in the memory of this controller. This function can be used to download or back up (upload) these data.

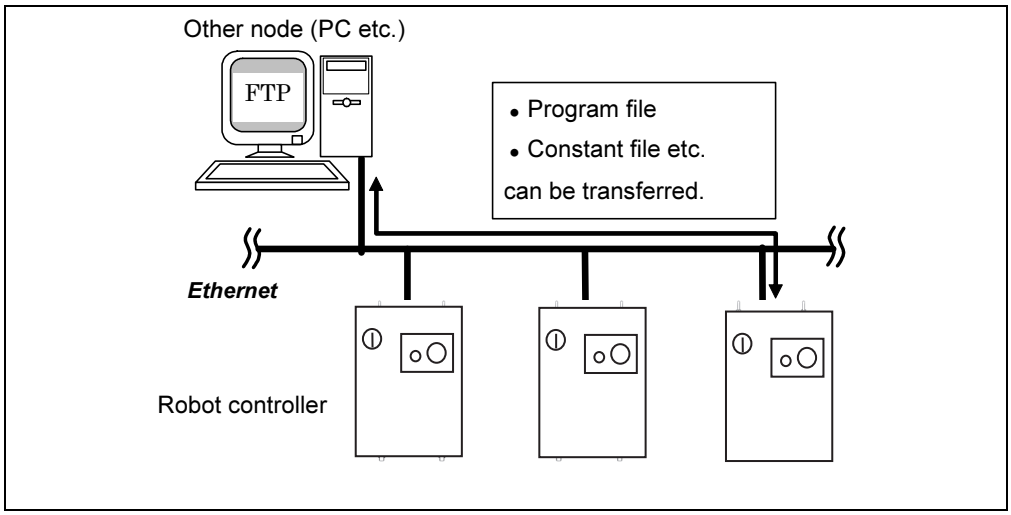


Fig. 7.1.1 Ethernet

To transfer files, the operation can be done both from the PC and from this controller.

POINT

See technical books offered commercially if necessary for various technical terms such as Ethernet, DHCP, IP address, subnet mask, default gateway, and FTP etc.

This instruction manual shows the operation for this controller. Prepare separately necessary software for the PC.

7.1.2 Network setting

To enable this controller to communicate on Ethernet networks, the network configuration including this controller shall be set at first. There are following two methods for that.

Select an appropriate method following the instructions of customer network administrator.

Table 7.1.1 Setting of network configuration

Method	Details
Automatic setting using DHCP	Network configuration is set automatically using DHCP (Dynamic Host Configure Protocol).
Manual setting inputting each setting value	Each setting value such as IP address or subnet mask is manually input from the screen of teach pendant. It is used when DHCP is not available for some reason.

File transfer between the node and this controller through the network will be available, when the setting according to the setting method in "7.1.2 Network setting" is completed and this controller is correctly recognized on the network.

IMPORTANT

Input each selection value such as IP address and subnet mask manually.

7.1.3 Connection of Ethernet cable

Connect the Ethernet cable to CNLAN1 connector which is located on the face of the CPU board.

When directly connecting this controller to PC without using switching HUB and or so, cross cable is needed to be prepared.

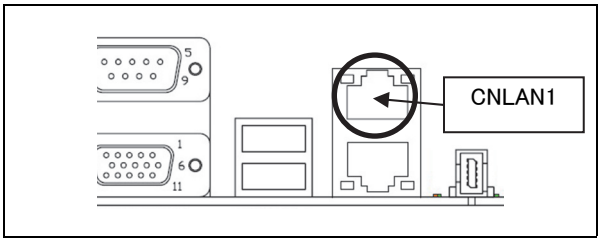


Fig. 7.1.2 Connection of Ethernet cable

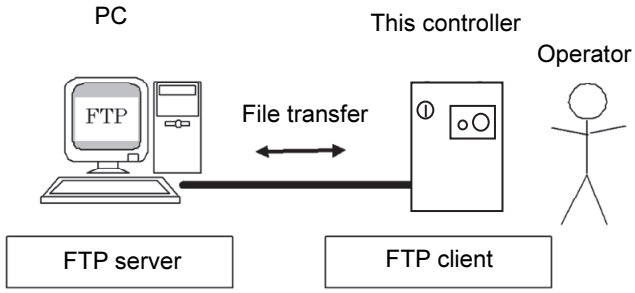
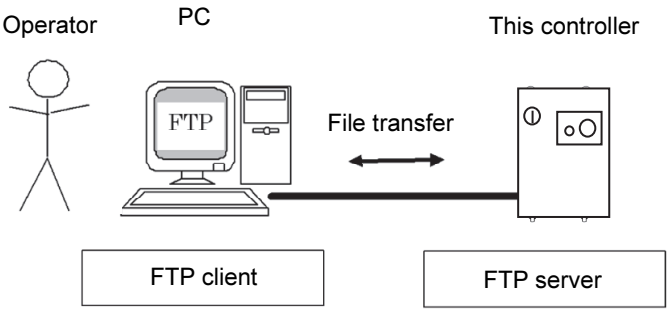
CAUTION

The CNLAN2 connector, which is the other side of the combo connector, cannot be used. If PC is connected to CNLAN2, this controller and PC cannot communicate with each other.

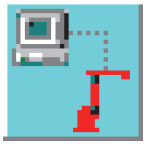
7.1.4 File transfer process

Transfer of files using FTP is performed between the FTP server and the FTP client. Operation is done at the FTP client to copy a remote file into a local computer and to copy a local file into a remote computer. There are following two methods to transfer files.

Table 7.1.2 File transfer method

FTP server	FTP client	Details
Other nodes (PC etc.)	This controller	Files are transferred using the operation menu of this controller. This controller works as an FTP client (the node to start the FTP requirement). 
This controller	Other nodes (PC etc.)	Files are transferred using FTP client software operating on other nodes. This controller works as an FTP server (host). 

When this controller is the FTP server and when one or more FTP clients are connected, the icon shown right will be displayed to indicate the connection. When the connection to the FTP server is disconnected, this icon will disappear.



7.2 Ethernet setting

The Ethernet menu has following functions that are set in the teaching mode / constant setting menu.
This important setting shall be done by customer network administrator. For this controller, the operator class of ***SPECIALIST*** is necessary.

Table 7.2.1 Constant setting menu of Ethernet

Operation menu	Details
TCP/IP	TCP/IP is set. Two methods are selectable: Automatic setting using DHCP or manual setting inputting each setting value. When manual input of each value is selected, input the IP address and the subnet mask etc.
FTP	FTP is set. This menu can change the FTP server setting set in the Microsoft Internet Information Server.

IMPORTANT

When ”system memory protection function” has been set to enabled,
”system memory protection function” is needed to be changed “disabled” before the setting of section “7.2.1 TCP/IP setting” or “7.2.2 FTP setting”.

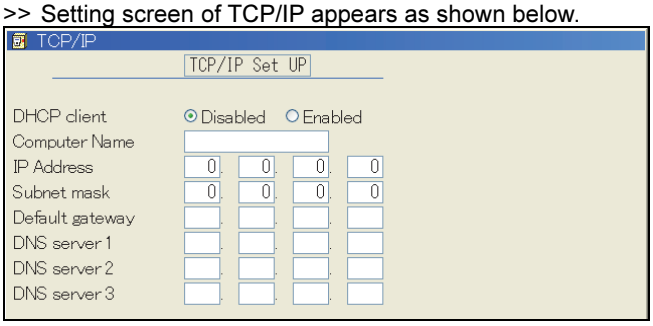
(1) Change the operator class to ***EXPERT*** or higher.
(2) Proceed to <Service Utilities> - [13 System Environments].
(3) Check the setting of System Memory Protection Function

7.2.1 TCP/IP setting

TCP/IP Settings

1 **Select Teaching Mode.**

2 **Select <Constant setting> – [8 Communication] – [2. Ethernet] – [1 TCP/IP].**
>> Setting screen of TCP/IP appears as shown below.



3 **Set the necessary parameter referring to "Table 7.2.2 TCP/IP setting".**

4 **When the setting is completed, press f12 <Complete>.**

5 **To enable the new settings, restore the power of the robot controller.**

Table 7.2.2 TCP/IP setting

Parameter	Description
DHCP client	Sets whether to use [DHCP client function] of this controller. When "Enabled" is selected, this controller sends DHCP requirement to the network at the time of power ON. When the DHCP host on the network responds, IP address, subnet mask, default gateway, and three or less DNS IP address are set automatically. If no response is given to the DHCP requirement of this controller, or DHCP is “Disabled”, the appropriate value shall be input manually. Ensure that DHCP requirement is generated only when the power of this controller is turned on. To send DHCP requirement again, power shall be restored.
Computer name	This is the computer name to identify this controller on the network.
IP address	This is the IP address to identify the TCP/IP host (this controller) on the network.
Subnet mask	This is the data to define the border (mask) for IP address so that TCP/IP can distinguish [Network ID] and [Host ID].
Default gateway	Specifies the gateway address if communication with the host in some other network is needed. Normally, it is not needed. If necessary, input the value instructed by your network administrator.
DNS server	This is the IP address of DNS server. Normally, it is not needed. If necessary, input the value instructed by your network administrator.

IMPORTANT

When the computer name or IP address overlap, communication will be disrupted. Ensure that the computer name and IP address are not duplicated in any of the devices that are connected to the network.

(Reference)
An error occurs if there are multiple robot controllers with the same "Computer name" in the same network. To avoid this error, please set the different names for the "Computer Name" in advance so that they do not overlap. For example, those names are

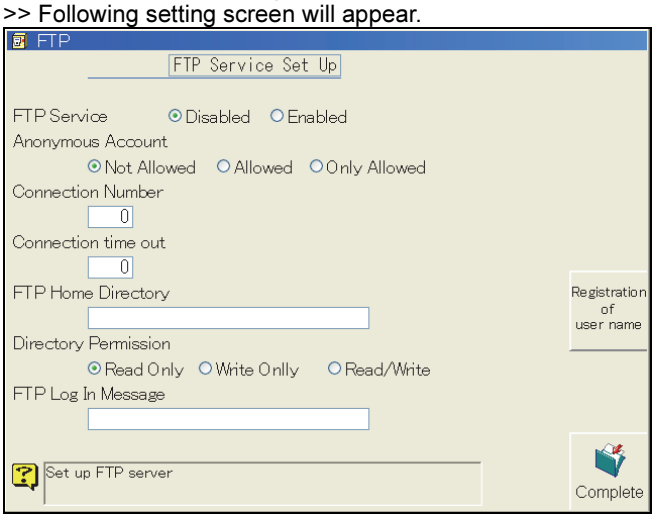
FD_CON_1
FD_CON_2
FD_CON_3

Of course, each IP address must also be set so that they do not overlap with the others.

7.2.2 FTP setting

FTP Settings

1 **Select <Constant setting> – [8 Communication] – [2 Ethernet] – [3 FTP].**
>> Following setting screen will appear.



2 **Set the required parameter referring to "Table 7.2.3 FTP setting".**

3 **When the setting is completed, press f12 <Complete>.**

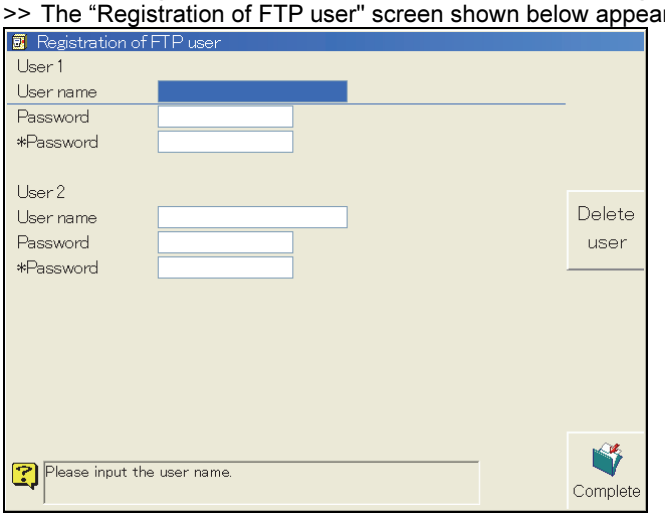
4 **To enable the new settings, restore the power of the robot controller.**

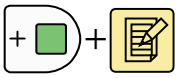
Table 7.2.3 FTP setting

Parameter	Description
FTP service	Sets whether to enable [FTP service function] of this controller. When it is enabled and controller power is turned on, FTP service will be started. When it is disabled, FTP service from the FTP client for this controller will be stopped.
Anonymous Account	Sets the authorization of anonymous connection. When [Only Allowed] is set, the user will not be able to log on with his/her user name and the password. The account that has the administrative access right will be prevented from accessing it, but only the account specified as an anonymous access can access it.
Connectable number	Sets the maximum connectable number to one server at the same time. The number can be from 1 to 10.
Timeout period	Sets the time to disconnect the inactive user from the server on the second time scale. The timeout period can be set in the 0 to 900 seconds. This value enables FTP protocol to close all the connection even when it fails.
FTP home directory	Sets the directory path to be used for FTP service. The directory path can only be set to directories under “D:¥”. The directory path cannot be set to any other directories.
Directory Permission	When “Write only” or “Read/Write” are selected, to write a file from a client to an FTP server is permitted. This setting is only for the directory to receive files from users.
FTP login message	Is displayed on the client connected to the FTP server for the first time.

Registrations of Users that Admit to Login

1 **Press f10<Registration of user name> on the FTP setting screen.**
>> The “Registration of FTP user" screen shown below appears.



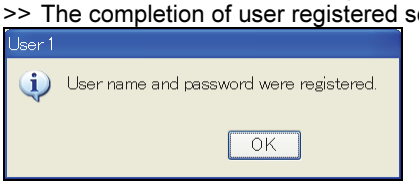


2 **Point the cursor with “User name” and input the user name which is admitted to login.**
For inputting character strings, press [ENABLE] and [EDIT] keys together to open the soft keyboard.

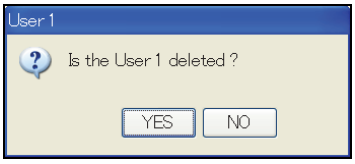
3 **Point the cursor to “password” and then input the password.**

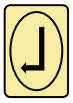
4 **Point the cursor to “*password” and then input the same password as 3.**

5 **Upon completion of the setting, press f12<Complete>.**
>> The completion of user registered screen shown below appears.



6 **When deleting the user, point the cursor to any of one “User name" or “Password” or “*Password”, and then press f9<Delete user>.**
>> The confirmation of user deleted screen shown below appears.





Select [YES] and press [Enter].
>> The user to be selected is deleted.

7.3 File transfer (FTP client)

Files are transferred using the operation menu of this controller. This controller works as an FTP client (the node to start the FTP requirement). To use FTP client function, Ethernet Setting such as TCP/IP and FTP has to be completed beforehand. The details are given in "7.2 Ethernet setting".

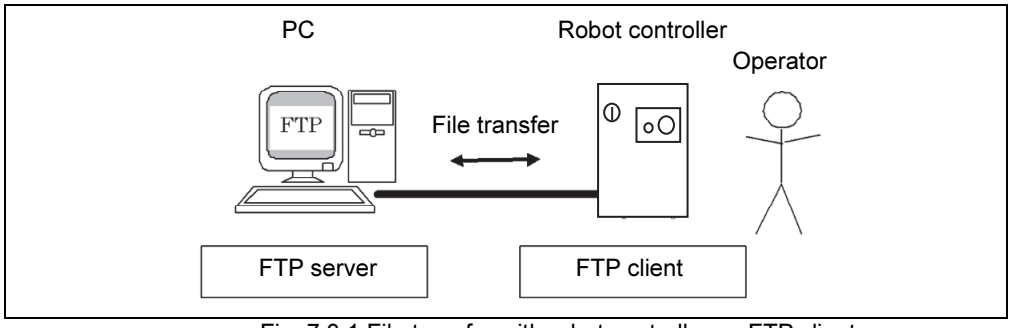


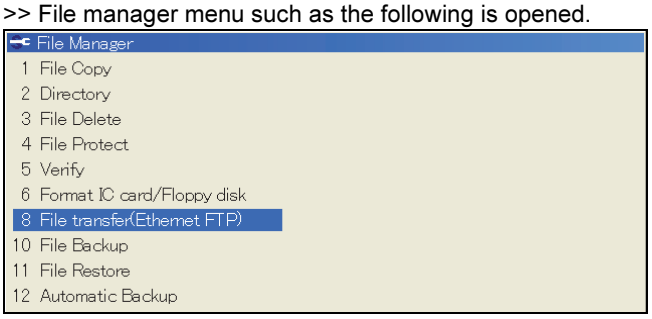
Fig. 7.3.1 File transfer with robot controller as FTP client

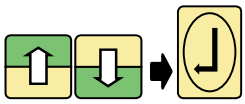
7.3.1 Registrations of FTP Server (Host)

Before using the FTP client function, it is necessary to set a host, which will be the FTP server for connection, according to the following steps.
Up to 2 FTP servers can be connected to this controller. This is an important setting and must be made by your network administrator. Operator class of ***SPECIALIST*** is necessary.

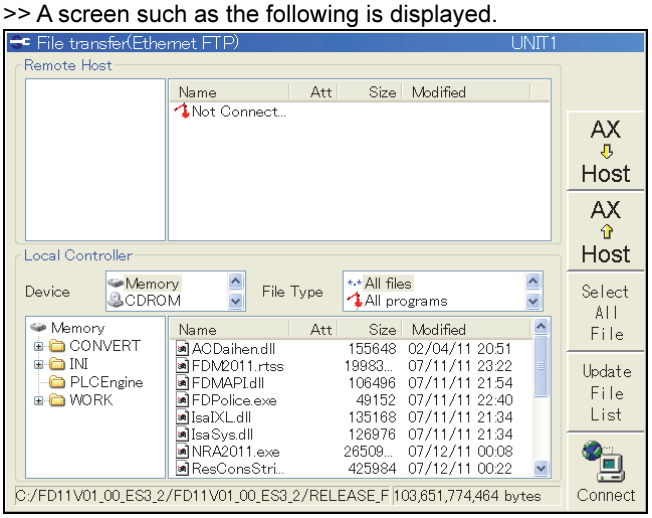
Registrations of FTP Server (Host)

1 **Press f4 <File>.**
When soft keys are not provided, service menu can be used for entry. In this case, select [7. File Manager] from service menu and press [Enter] key
>> File manager menu such as the following is opened.

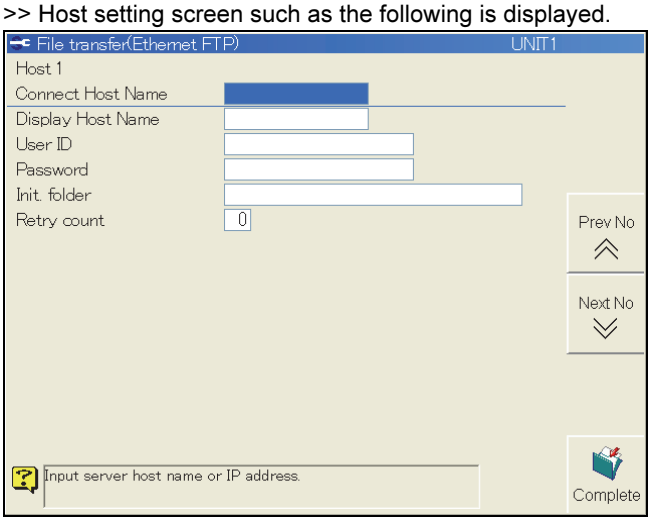




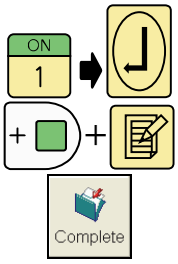
2 **Align the cursor on the [File Transfer (Ethernet FTP)] and press [Enter] key.**
>> A screen such as the following is displayed.



3 **Press f7 <Setting of Host>.**
>> Host setting screen such as the following is displayed.



4 **Refer to Table 7.3.1 Host setting and set necessary parameters.**



5 **When the edit box is available, enter numerical values and press the [Enter] key.**

For entering character strings, soft keyboard can be used by pressing the [ENABLE] key and the [EDIT] key simultaneously

6 **When the host has been set, press f12<Complete>.**

Table 7.3.1 Host setting

Parameters	Functions
Connect Host Name	Used to set the name of host for connection on the network. IP address can also be set directly. Up to a maximum of 15 characters can be entered.
Display Host Name	Used to set the host name for display on the FTP client menu. Up to a maximum of 15 characters can be entered.
User ID	Used to set the user name for logging it into the host. Up to a maximum of 20 characters can be entered.
Password	Used to set the password for logging in with the above user ID. Up to a maximum of 128 characters can be entered.
Init. folder	Used to set the folder pass to refer to when the connection to the host is completed. Enter the relative pass from the home directory of the host. '¥' is used to delimit the folder. Up to a maximum of 260 characters can be entered.
Retry count	When data logging into the host is failed, set the repeating number of data logging.

Host setting is also used for automatic backup function. When the backup device is set to "Host 1" or "Host 2", host is connected with this setting during backup operation. In this case, a backup folder is created on the initial folder of the set host for connection.

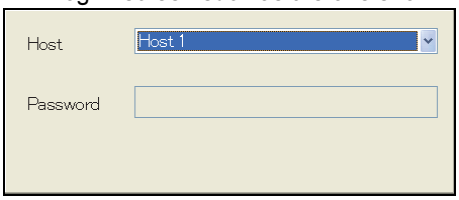
7.3.2 File download

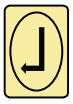
Remote files are copied to the local computer (this controller).
Operator class of ***EXPERT*** or higher is necessary for this operation.

File Download

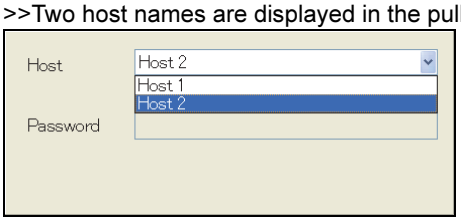
1 to 2 Perform the same operation as "7.3.1 Registrations of FTP Server (Host)".

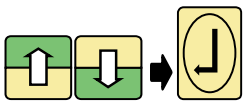
3 Press f12<Connect> to connect to the FTP server.
>> A log-in screen such as the one shown below appears.



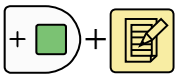


4 Position the cursor on the host selection column and press the [Enter] key.
>>Two host names are displayed in the pull-down menu as shown.

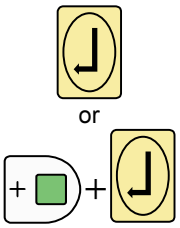




5 Select the host for connection with [Up] or [Down] keys and press the [Enter] key.

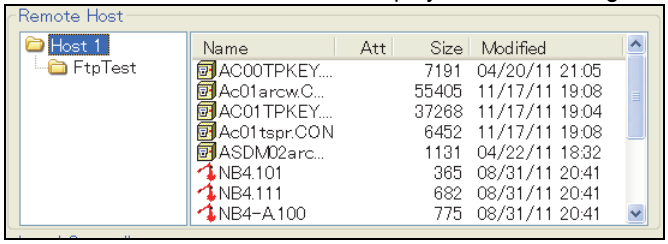


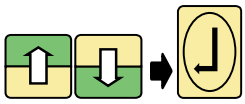
6 Input the password for logging in to the FTP server in the "Password" field.
If the user ID is set to "Anonymous," leave this field blank.
For inputting character strings, press [ENABLE] and [EDIT] keys together to open the soft keyboard.



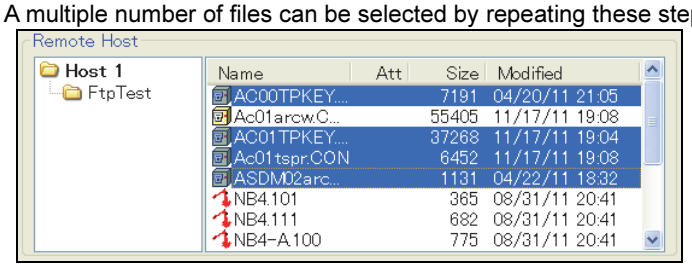
7 When the cursor is in the password column, press the [Enter] key. When the cursor is in the host column, press the [ENABLE] key and the [Enter] key.
The host is connected to the specified FTP server.
Login screen is closed automatically.

8 When host is connected properly, the file in the initial folder is displayed. The initial folder is set by the host setting mode. (Refer to "7.3.1 Registrations of FTP Server (Host)"). When the initial folder is not set or when the directory set in the initial folder does not exist under the home directory, internal home directory is displayed.
In this case, the beginning of the folder list is displayed by the name set in the host name for display.
>> The file list of the FTP server is displayed. The following is an example.





9 **Select a file in the FTP server to be transferred.**
Select a file using the [Up] or [Down] key, and press [Enter]. The selected file is highlighted in blue.
A multiple number of files can be selected by repeating these steps.



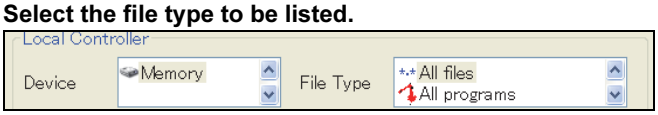
To release the selected status, select the file to be released, and press [BS].

To select all files, press the f10<Select All File>.

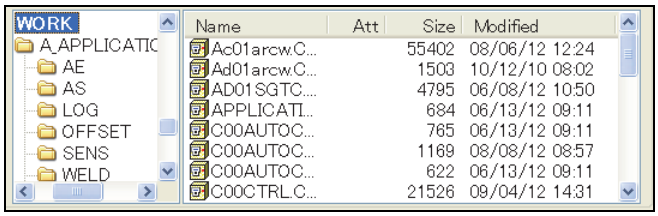
When the all file selection mode is reset, press the <Release All File> (ENABLE + f10).

10 **Move to the “Device” selection field in the “Local controller” (this controller) section, and select a device.**

11 **Select the file type to be listed.**



12 **Select the folder of the local controller (this controller) to which the files are to be transferred.**



13 **Press f9 <Host->FD> after selection.**
>> File transfer (downloading) now starts.

14 **Upon completion of all the File transfer needed, press the [RESET/R] key to close the menu.**

During the playback operation, no constant files or initial-value files which affect the robot operation are allowed to download.

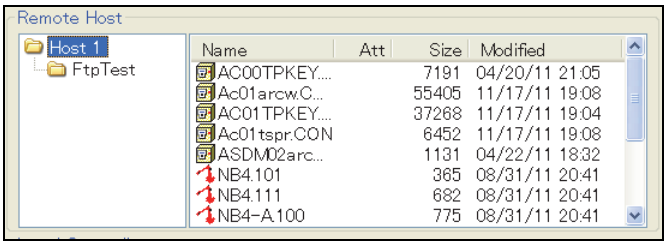
7.3.3 File upload

Copy local files into the remote computer as described below.
Operator class of ***EXPERT*** or higher is necessary for this operation.

File Upload

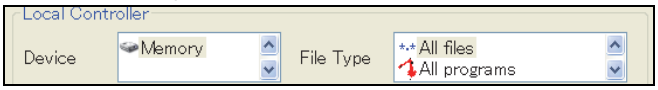
1 to 8 Perform the same process as download from step 1 to 8.

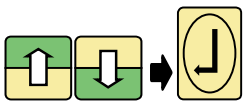
9 At the remote host, select the folder to which files are transferred.



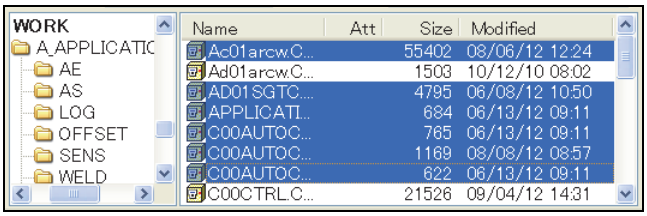
10 At the device selection field of the local controller, select the device.

11 Select the file type to list.





12 Select the file to transfer at the local controller.
Select the file with [Up] or [Down], and press [Enter]. The selected file will be highlighted in blue.
Multiple files can be selected by repeating this operation.



To release the selected status, select the file to be released, and press [BS].

To select all files, press the f10<Select All File>.

When the all file selection mode is reset, press the <Release All File> (ENABLE + f10).

13 Press f8 <FD-> Host>.
>> File transfer (upload) starts.

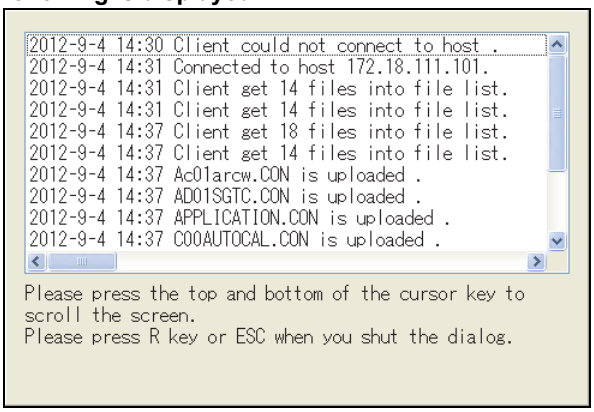
14 When the necessary file transfer is completed, press [RESET/R] to exit the menu.

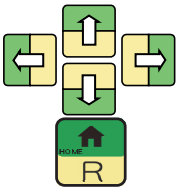
7.3.4 Referent Log

Record of communication with the FTP server is referenced.
Operator class of ***SPECIALIST*** is necessary for this operation.

Operations are the same as those of down load operation from 1 to 2.

3 Press the <Referent Log> (ENABLE + f8) key and the log list such as the following is displayed.





4 To display the list, press [Up] or [Down] keys for vertical list scrolling and press [Right] or [Left] keys for lateral list scrolling.

5 Pressing the [RESET/R] key ends the log list screen.

Table 7.3.2 Log Setting

Status	Log display
Sever connection succeeded	Host: Server was connected to the [Host name].
Server connection failed	Host: Server could not be connected to the [Host name].
Server connection shutoff	Server connection was shut off.
Folder list Acquisition succeeded	[File number] file was acquired in the file list.
Folder list Acquisition failed	File could not be acquired in the file list.
1 file Upload execution	[File name] was uploaded.
Write inhibit file Upload	[File name] is protected and could not be uploaded.
Upload when writing of the same name file is inhibited	[File name] could not be uploaded due to “Do not overwrite” operation.
Upload when the capacity is insufficient	[File name] could not be uploaded because of insufficient storage capacity.
Upload failed due to unknown cause	[File name] could not be uploaded
Upload suspended	Uploading was suspended.
1 file Download execution	[File name] was downloaded.
Changing in playback mode not allowed File Download	[File name] could not be downloaded due to playback mode.
Write inhibit file Download	[File name] is protected and could not be downloaded.
Download when writing of the same name file is inhibited	[File name] could not be downloaded due to “Do not overwrite” operation.
Download when the capacity is insufficient	[File name] could not be downloaded because of insufficient storage capacity.
Download failed due to unknown cause	[File name] could not be downloaded.
Download suspended	Download was suspended.

7.4 File transfer (FTP server)

Files are transferred from FTP client software operating on some other node as described below. This controller works as an FTP server (host).

No operation is especially required at this controller. Files can be transferred even while playback operation. To use the FTP server function, Ethernet setting such as TCP/IP or FTP shall be completed beforehand. The details are given in "7.2 Ethernet setting".

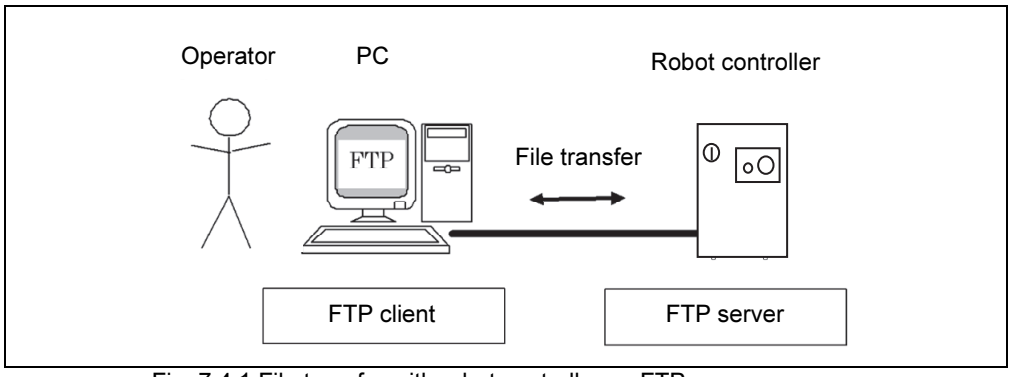


Fig. 7.4.1 File transfer with robot controller as FTP server

IMPORTANT

Be careful when files are transferred to this controller during the playback operation.
Do not transfer constant files or initial-value files which directly affect the robot operation.
Caution is demanded when the FTP server function is used, because special restriction for the file transfer is not applied in this controller.

NOTE

NACHI NACHI-FUJIKOSHI CORP.	***www.nachi-fujikoshi.co.jp***	
NACHI-FUJIKOSHI (CHINA) CO., LTD.	***www.nachi.com.cn***	
NACHI ROBOTIC SYSTEMS, INC. (NRS)	***www.nachirobotics.com***	
NACHI EUROPE GmbH	***www.nachi.de***	

- Concerning the Contact list, please refer to ***"Contact list (TFDJP-254)"***.
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- In case that an end user uses this product for military purpose or production of weapon, this product may be liable for the subject of export restriction stipulated in the Foreign Exchange and Foreign Trade Control Law. Please go through careful investigation and necessary formalities for export.
- This is an original instruction.