1509, TFDEN-159-003, 001

NACHI

CFD CONTROLLER INSTRUCTION MANUAL SETUP MANUAL

3rd 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.

Table of Contents

Chapter 1 Point on Safety

Chapter 2 Transportation and Installation

Chapter 3 Setup

Chapter 6 Initial setting with Compact TP

Chapter 7 Synchro-motion function setup

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 safe 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 struck while a robot system was used are shown in Table 1.1.1.

Table 1.1.1 Conditions when a disaster struck

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 get 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.

DANGER

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 work.

DANGER

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.

DANGER

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

CAUTION

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

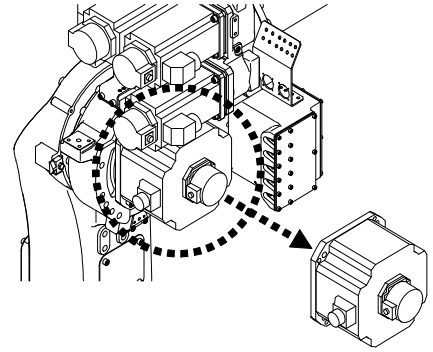
The manipulator is of such design that no unnecessary protrusions or sharp corners exist. It is made of suitable material for use in the environment for which it was designed and has fail-safe construction to minimize damage or accidents during operation. The manipulator maintains a good level of safety 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.

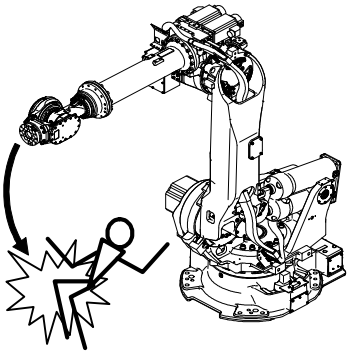
WARNING

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.

CAUTION

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.

CAUTION

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

CAUTION

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.)

CAUTION

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.

CAUTION

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.

CAUTION

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

WARNING

LOCKOUT AND TAG OUT EQUIPMENT,
BEFORE SERVICING.

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 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.

CAUTION

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.

CAUTION

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.)

CAUTION

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.

DANGER

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.

CAUTION

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.

CAUTION

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.

CAUTION

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

CAUTION

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.

WARNING

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.

WARNING

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.

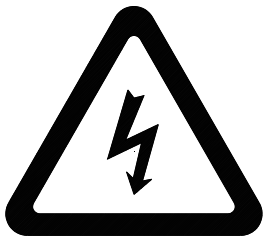
Cautions about Batteries

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 amply with clean water such as city 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 step-down transformer case cover of the robot controller, and the connectors of control cables of the manipulator. This mark indicates the power supply part.

WARNING

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.

WARNING

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.

	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.

DANGER

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.

WARNING

Under a cover displaying this mark on 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 requiring the removal of any of these covers.

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.

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.

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.

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.

(If welding machines exist in the plant)

(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.

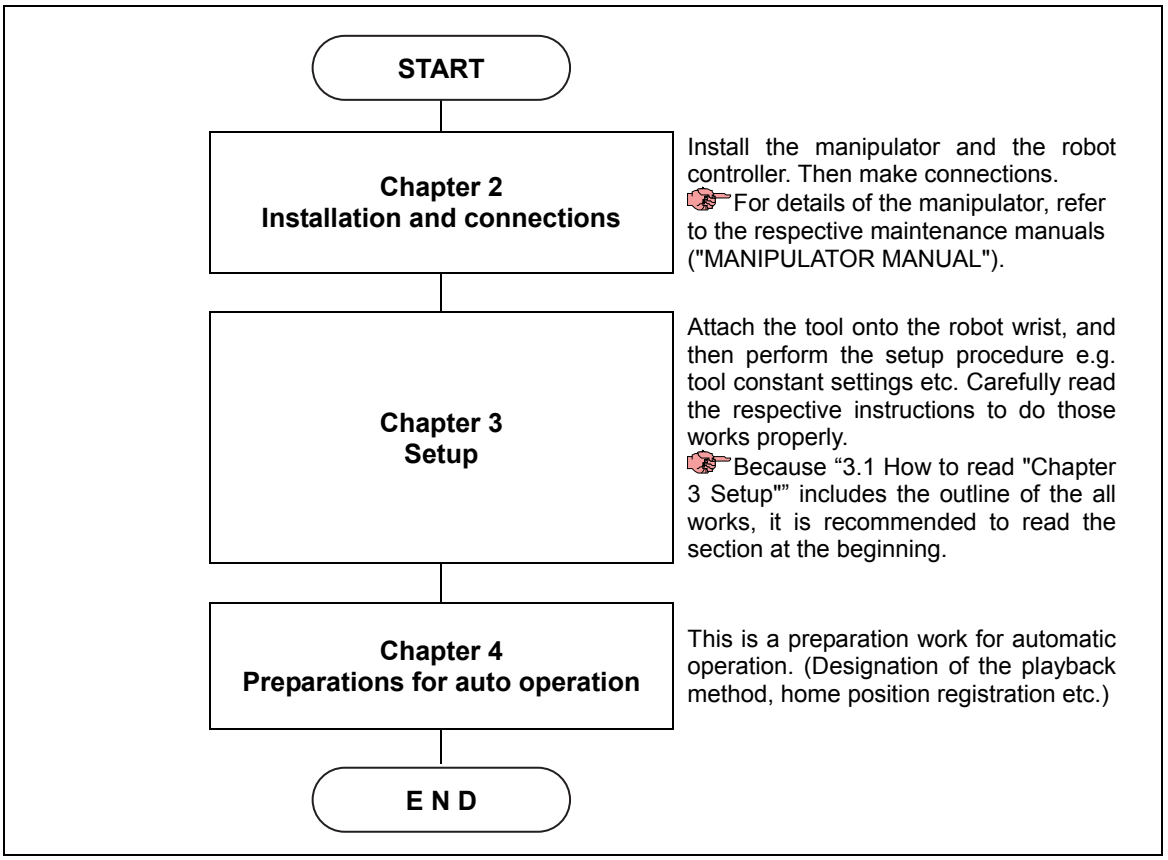
(5) Follow the instructions below to safeguard against the effects of the electromagnetic noise which is generated by the welding arcs.
(a) Install precision instruments, etc. at a distance from the welding arcs.
(b) Use one incoming power supply for the welder and another for the precision instruments,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

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 MANIPULATOR MANUAL 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.



To setup the Ethernet communication, refer to the following section also.
“Chapter 5 Ethernet”

When using a Compact Teach Pendant, refer to the following section also.
“Chapter 6 Initial setting with Compact Teach pendant”

Concerning the I/O interfaces, the RMU (Robot Monitoring Unit), the additional axis, etc., please refer to the following instruction manuals.

“CFD CONTROLLER TECHNICAL DOCUMENT 1” (TCFEN-155)
“CFD CONTROLLER TECHNICAL DOCUMENT 2” (TCFEN-156)

2.2 Installation of this controller

2.2.1 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 40 degrees Celsius throughout the year.

(2) A location with an ambient relative humidity of 20 to 85% and no condensation.

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

(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.

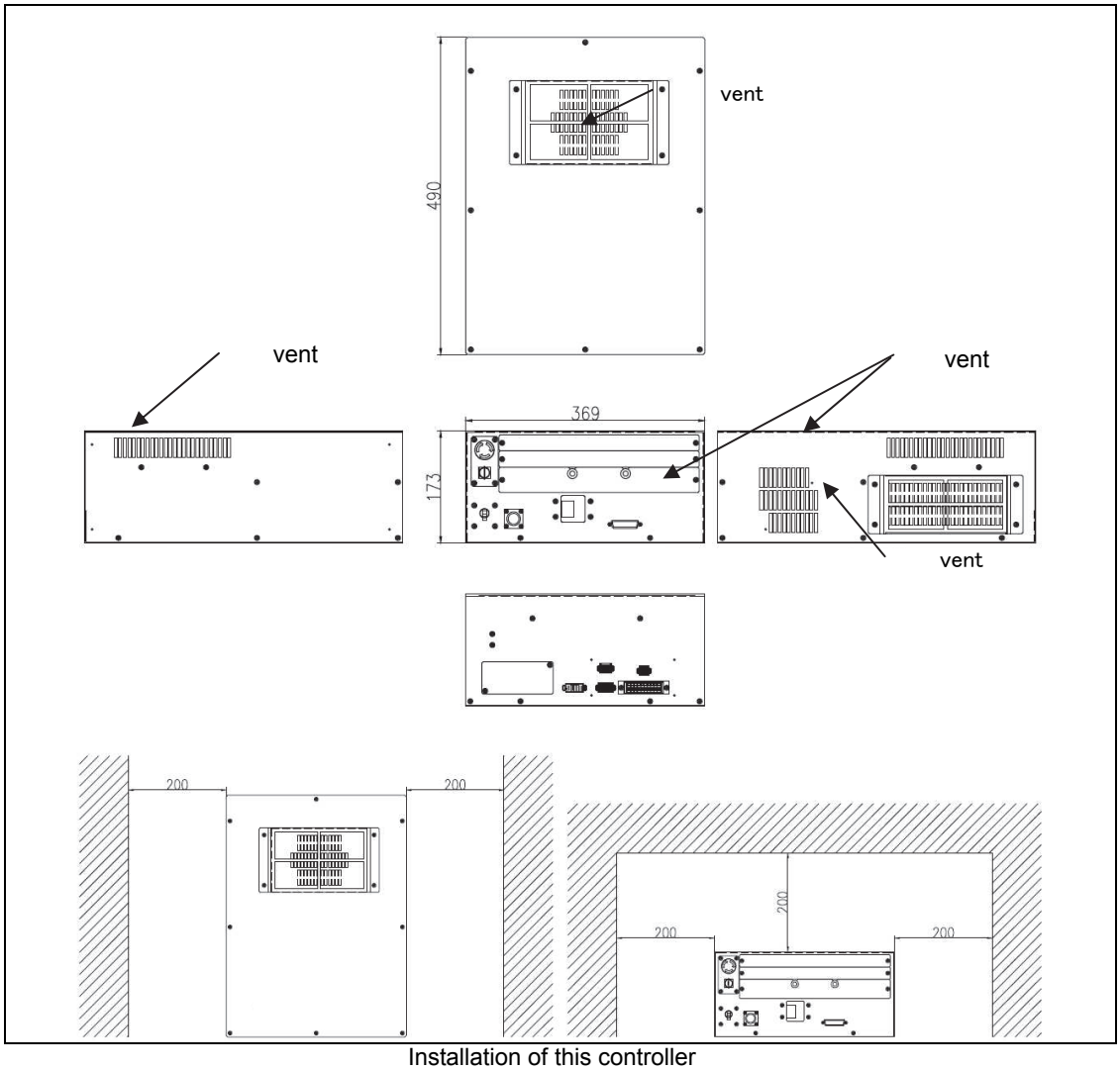
(6) A location with no major sources of electrical noise (plasma, high frequency power sources, etc.).

2.2.2 Install dimensions of robot controller

(1) When installing the controller, leave a clearance of at least 200 mm between the controller and the wall behind it in order to ensure proper ventilation inside the robot controller.

(2) Install the controller so that the height from the working floor to the main power switch is between 0.6 m and 1.9 m.

(3) CFD controller itself is not dust-proof and splash-proof structure. To use this controller in the environment of dusts or mist environment, please add the controller protection box option (CFD-OP133-A).



Installation of this controller

2.3 Robot installation

The locations in which the robot is installed and the method used to install it are critical for ensuring that the functions of the robot will be maintained.

The ambient atmosphere in the installation location not only affects the lifespan estimation of the mechanisms but it also has a bearing on safety.

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

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

And, install guard fences around the robot to cover the all motion range of the robot.
(To keep persons out from the area while the robot is running)

DANGER

The robot controller or the operation panels, etc. must be placed outside of the guard fence (= robot’s motion range). If this is not kept, death or serious injury may happen when a person tries to operate the robot.

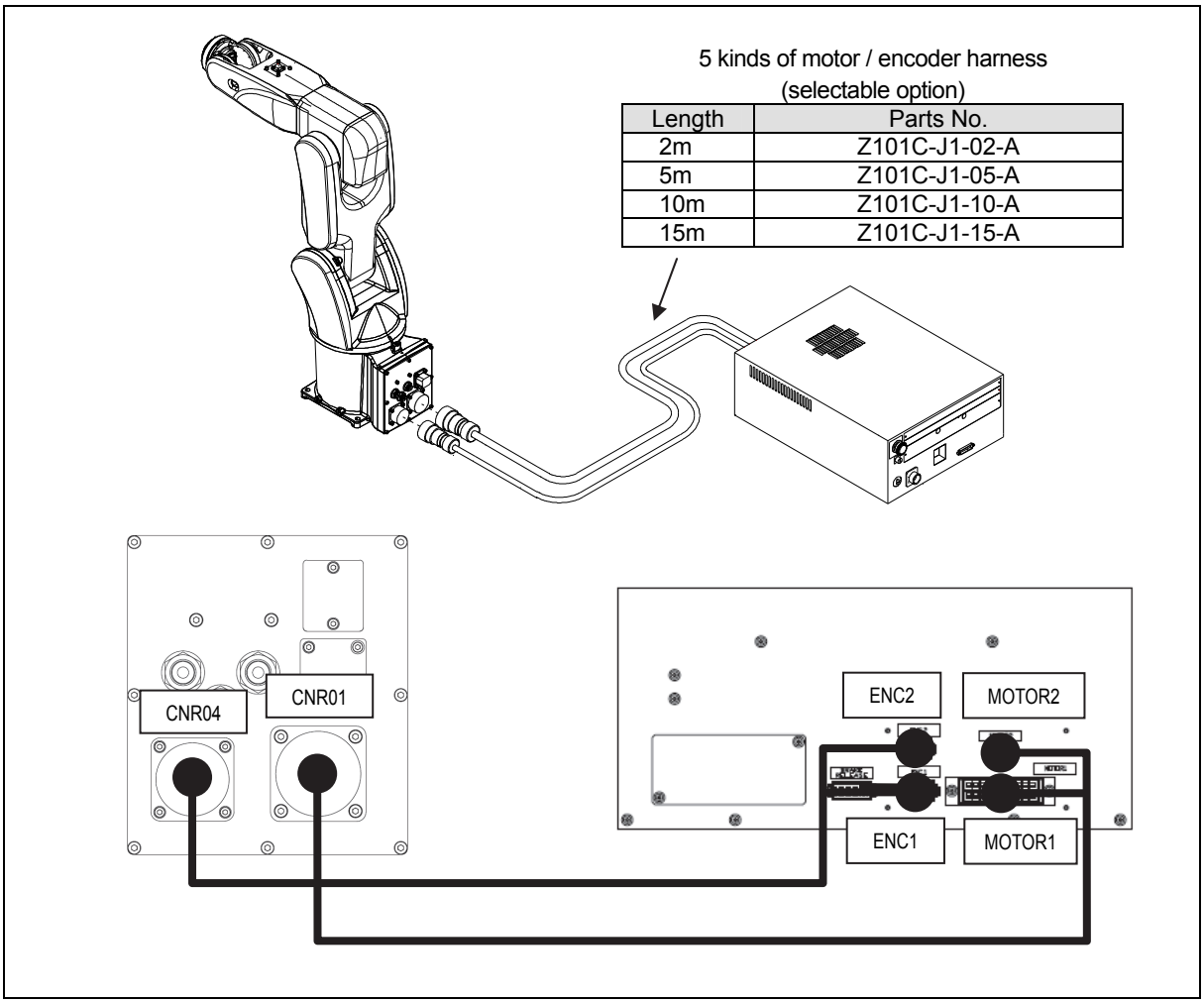
2.4 Robot connection

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.

2.4.1 Connection of CNR01 and CNR04

Connect the robot and the controller referring to the following picture. Its structure can prevent from wrong connection, so forcing connectors together will cause damage. Be careful when making connections.



Connection of CNR01 and CNR04 (An example of MZ07 and CFD)

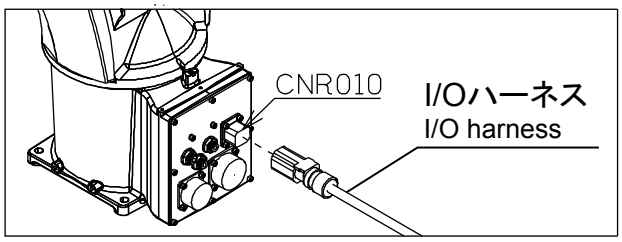
IMPORTANT

The connector layout or the connecter shape may vary from the manipulator type.

2.4.2 Connection of CNR10 (option)

The connector CNR010 on the backside panel of the robot is for application signals.
Connect this referring to the following figure.

For the CFD controller side, see the section of “2.6.1 Cable connection”.



IMPORTANT

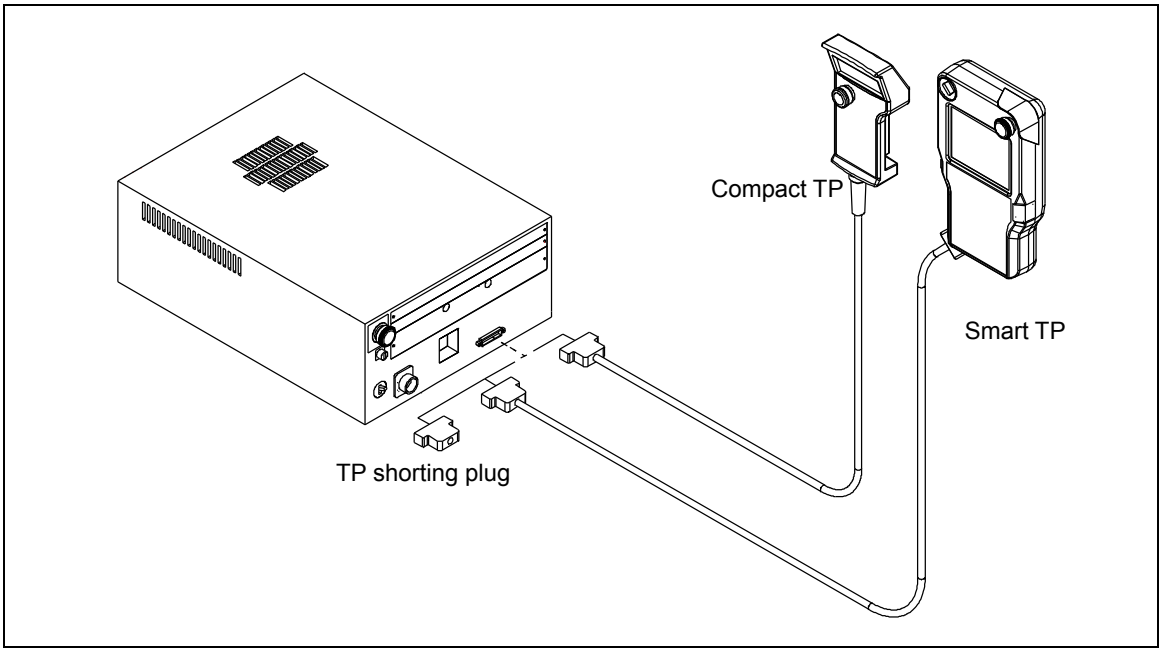
- For details about the I/O harness and the connector, refer to the following manuals also.

“MANIPULATOR MANUAL”
“CFD CONTROLLER TECHNICAL DOCUMENT 1” (TCFEN-155)
“CFD CONTROLLER TECHNICAL DOCUMENT 2” (TCFEN-156)

- The connector layout or the connector shapes may differ from each other depending on the robot model.

2.5 Teach pendant (TP) connection

Connect the teach pendant (the Compact TP or the Smart TP) to the connector TEACH PENDANT on the front panel and lock the connector with the screws on the connector.



Teach pendant (TP) connection

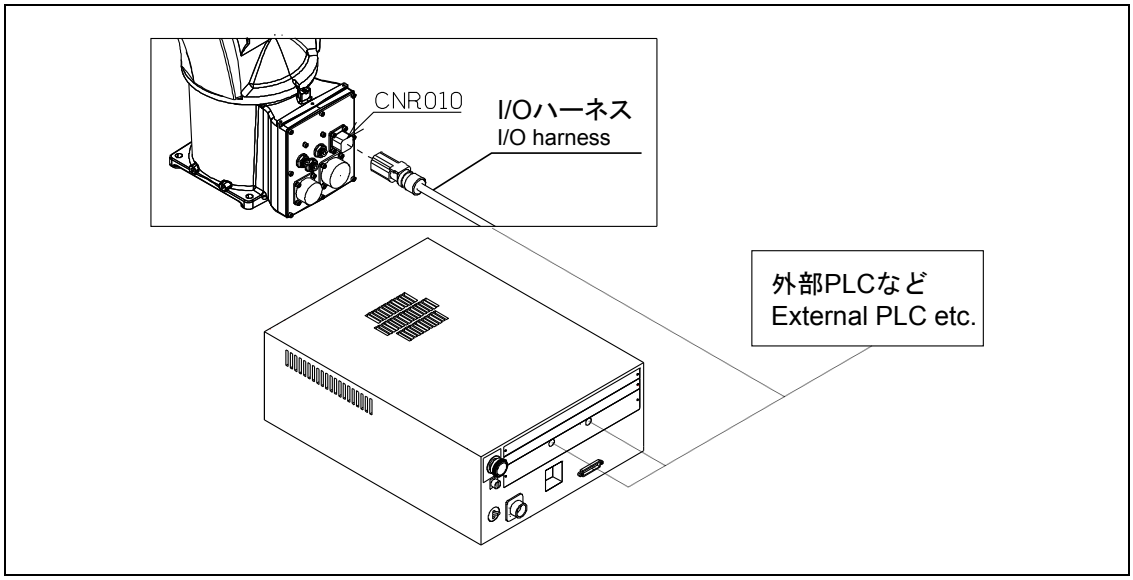
IMPORTANT

If “TP shorting plug” is connected, it becomes impossible to operate the robot manually. Therefore, at least 1 teach pendant (Compact TP or Smart TP) must be prepared in 1 plant.

2.6 External equipment connection

2.6.1 Cable connection

Connect the cable that come out from the CFD controller to the external PLC or the robot etc.
(The number of the cables or the connection destination differs from the specification or the system configuration etc.)



Connection to the external devices

IMPORTANT

The I/O connection, settings for the DeviceNet, CC-Link, etc.
Refer to the instruction manual;
"CFD CONTROLLER TECHNICAL DOCUMENT 2" (TCFEN-156)

Robot side I/O connection
For details of the CNR010, see the instruction manual ***"MANIPULATOR MANUAL"***.
For details of the I/O harness, see the instruction manual;
"CFD CONTROLLER TECHNICAL DOCUMENT 1" (TCFEN-155)

2.6.2 To start the program using the external PLC etc.

See the following manuals.

"CFD CONTROLLER TECHNICAL DOCUMENT 2" (TCFEN-156)

and

"CFD CONTROLLER INSTRUCTION MANUAL : BASIC OPERATIONS MANUAL" (TCFEN-160)
Chapter 5

2.7 Primary power and the grounding connection

2.7.1 Prior to Primary power supply connections

WARNING

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 tallies with the voltage specification of the robot controller. The voltage of the robot controller is indicated near the circuit breaker.

The primary power supply specifications of the robot systems are as follows.

Rating of primary power

Manipulator used in combination	Rated voltage	Power-handling capacity (Note)
MZ series	3-phase AC200V-230V Single-phase AC200V-230V (+10%, -10%) 50/60 Hz	0.4 kVA
MC10S / CFD-3000	3-phase AC200V-230V Single-phase AC200V-230V (+10%, -10%) 50/60 Hz	1.5KVA

(Note) Varies according to the application and operation pattern.

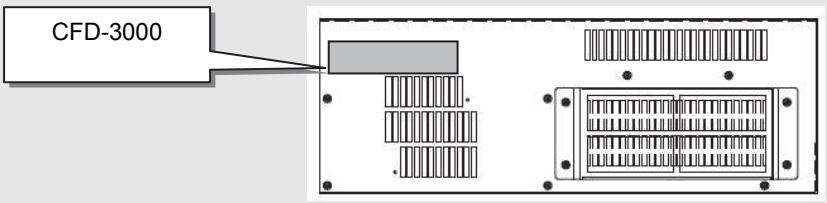
For the specifications of other manipulators, refer to each standard specification sheet.

IMPORTANT

When multiple manipulators or external axes are combined, a power capacity equivalent to the total power of all the machines is required.

IMPORTANT

In case of CFD-3000, a sticker of “CFD-3000” is on the side panel.



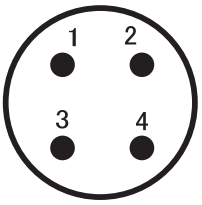
In case of CFD-0000 controller, there is not sticker like this.

2.7.2 Assembling the Primary power supply cable

By referring to the following figure, solder the power supply cable to the power supply connector.

Connector pin layout

Seeing from the soldering side



Applicable cable diameter:
10 – 12.5 [mm]
Connector type
Nanaboshi Electric Mfg.Co.,Ltd.
NJC-204-PF

PIN No.	Connection	
	3 - phase AC200V	Single - phase AC200V
1	AC200V R-phase (Red)	AC200V R-phase (Red)
2	AC200V S-phase (White)	-
3	AC200V T-phase (Black)	AC200V T-phase (Black)
4	Ground (Green/Yellow)	Ground (Green/Yellow)

Primary power supply cable connection

Primary power supply cable specification

Manipulator used in combination	Cross-section of power cable	Cross-section of grounding cable
MZ series	1.25 mm^2 AWG16	1.25 mm^2 AWG16
MC10S / CFD-3000	1.25 mm^2 AWG16	1.25 mm^2 AWG16

(NOTE) The type name of the bushing attached to the NJC-204-PF is NJC-20-CB.

2.7.3 Connecting the Primary power supply cable

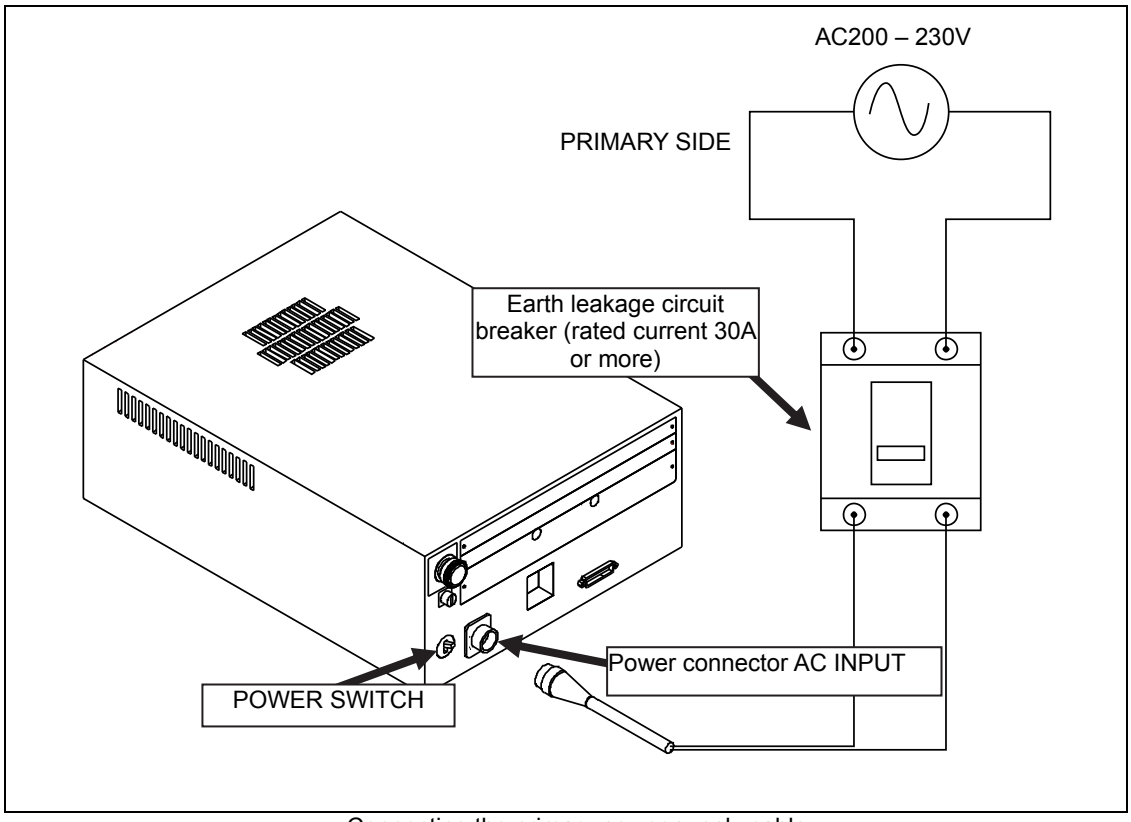
WARNING

1. Electric shock may cause serious injury or death.
   Wiring work should be done after turning OFF the power switch of the robot controller. And the power distributer (PRIMARY SIDE) panel also should be turned OFF.
2. Check that the voltage of the primary power supply tallies with the voltage specification of the robot controller. The voltage of the robot controller is indicated near the circuit breaker.

CAUTION

1. An inverter circuit for controlling the AC servo motor is used in this robot controller.In order to prevent the earth leakage circuit breaker from being tripped in error by the high-frequency leakage current generated from the inverter circuit, the earth leakage circuit breaker must be designated for inverter use when one is to be used.
2. When installing the earth leakage circuit breaker, use one with rated current 30A or more and a medium current sensitivity(100 mA or more).

Turn OFF the power of the controller and connect the power supply cable to the connector AC INPUT.



Connecting the primary power supply cable

2.7.4 Grounding

To ensure safety, use the grounding method (type D ground)
(The customer is responsible for providing the grounding wires.)

Ensure that the robot controller power cable is larger than 1.25 mm^2, and ground cable is larger than 1.25 mm^2.

Set the ground resistance to less than 100 ohms.

2.8 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.

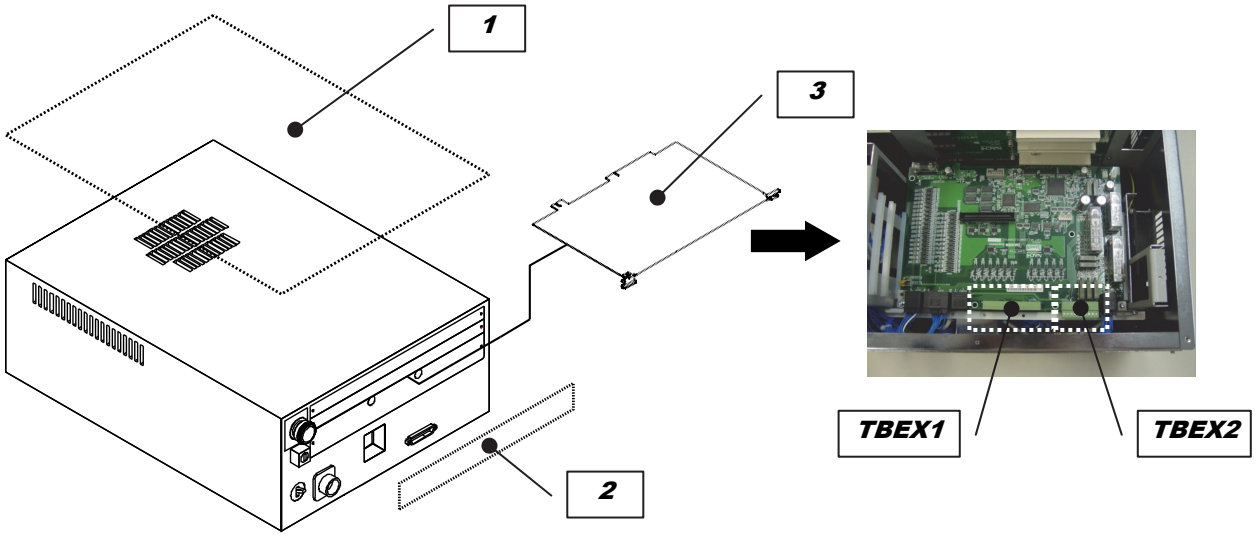
This controller comes with safety redundancy circuits as a standard feature. Connect a separate pair of signals each for the external emergency stop input, safety plug input and enable switch input. The controller will not work properly if any of the separate pairs of signal inputs are mismatched in the safety redundancy circuits.

CAUTION

A safety plug or enable switch is required to perform the teaching work inside the guard fence. These connections must be performed without fail. If a safety plug is not going to be used, install a “switch that permits automatic start” outside the guard 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 guard fence, and connect its signal to the safety plug input.

2.8.1 Sequence board

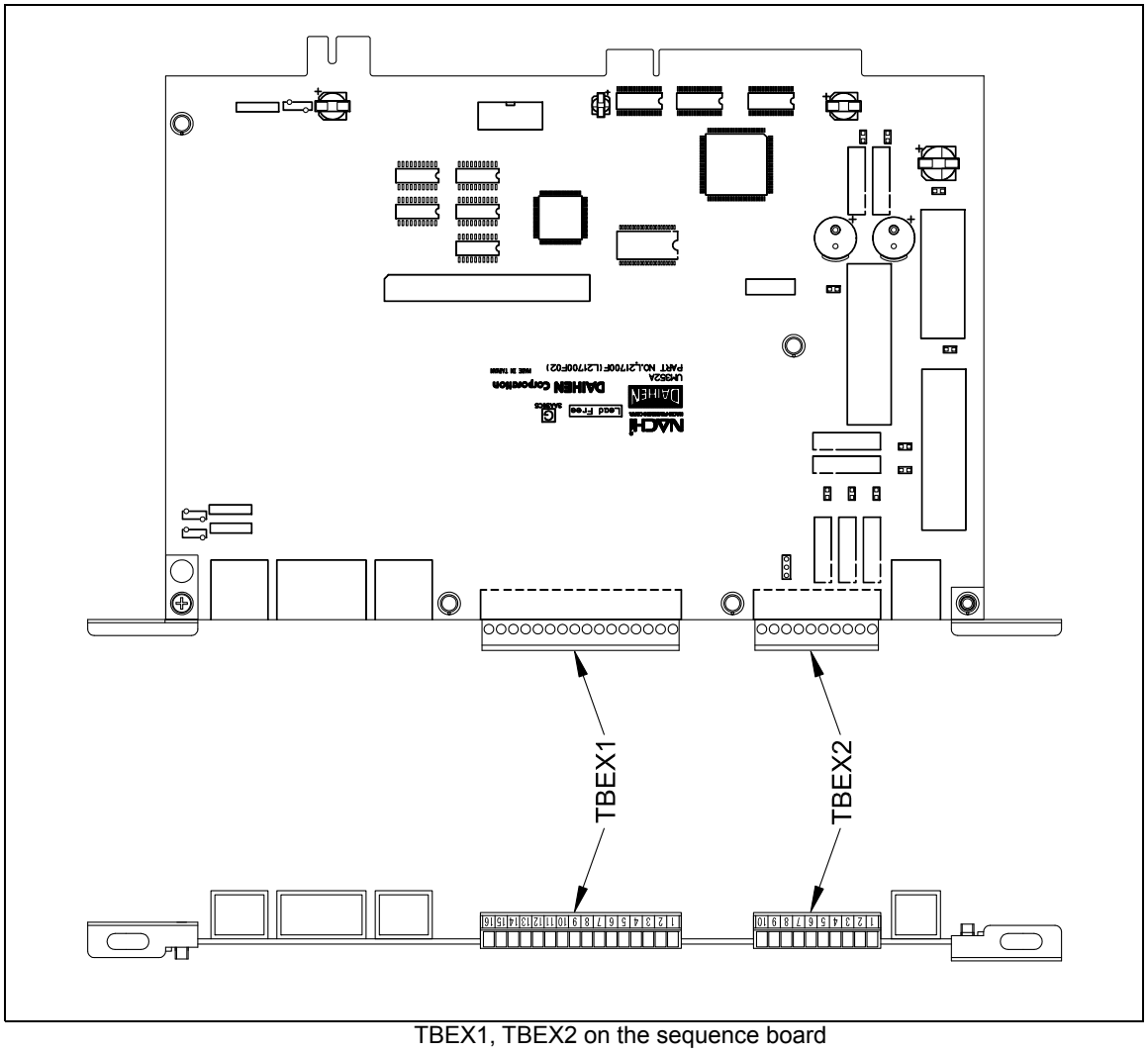
The terminals for the safety-related signals are located on TBEX1, TBEX2 on “Sequence board”.



(1) Remove the top panel.
(2) Remove the front panel.
(3) Remove the sequence board from the CFD controller’s slot.

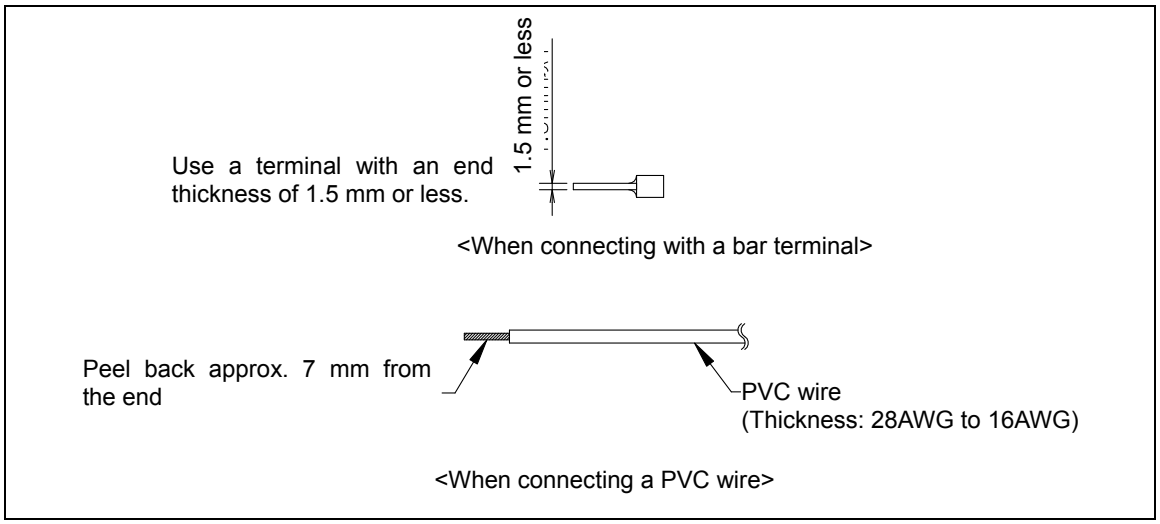
For details of the sequence board, refer to the following pages.

2.8.2 Terminal block TBEX1 and TBEX2



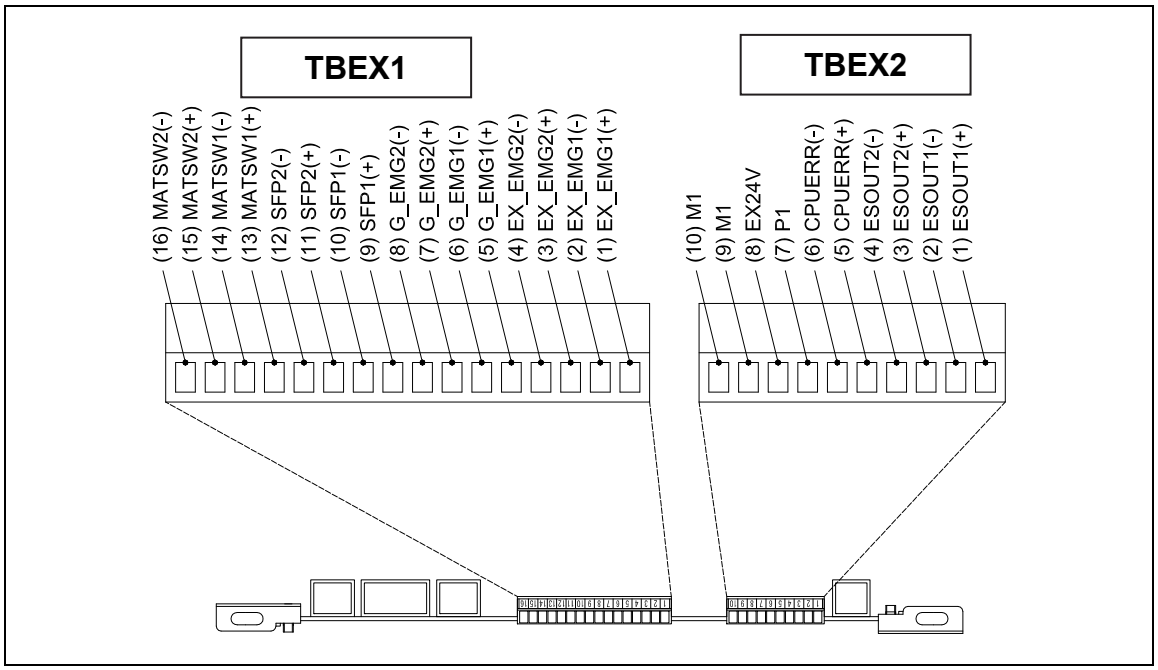
TBEX1, TBEX2 on the sequence board

For the signal wire that will be connected to the terminal block, use a bar terminal (end thickness of 1.5 mm or less) or a PVC wire (thickness 28AWG to 16AWG) with approximately 7 mm of the end peeled off.



Signal wires to connect to TBEX1 and TBEX2

2.8.3 Pin layout of the terminal block TBEX1 and TBEX2



Pin layout of TBEX1 and TBEX2

Terminal block TBEX1 of Sequence board

Pin No	Signal name	Function	Description
16	MATSW2	Teaching enable switch input 2-	This is a teach enable switch input terminal. When not using this terminal, connect jumper wires as shown below. Connect 13 and 14 Connect 15 and 16
15		Teaching enable switch input 2+	
14	MATSW1	Teaching enable switch input 1-	
13		Teaching enable switch input 1+	
12	SFP2	Safety plug input 2-	This is a safety plug input terminal. Connect always. See 2.8.6
11		Safety plug input 2+	
10	SFP1	Safety plug input 1-	
9		Safety plug input 1+	
8	G_EMG2	G-STOP input 2−	This is G-STOP input terminal. When not using this terminal, connect jumper wires as shown below. Connect 5 and 6 Connect 7 and 8
7		G-STOP input 2＋	
6	G_EMG1	G-STOP input 1−	
5		G-STOP input 1＋	
4	EX_EMG2	External emergency stop input 2-	This is an external emergency stop input terminal. When not using this terminal, connect jumper wires as shown below. Connect 3 and 4 Connect 1 and2
3		External emergency stop input 2+	
2	EX_EMG1	External emergency stop input 1-	
1		External emergency stop input 1+	

CAUTION

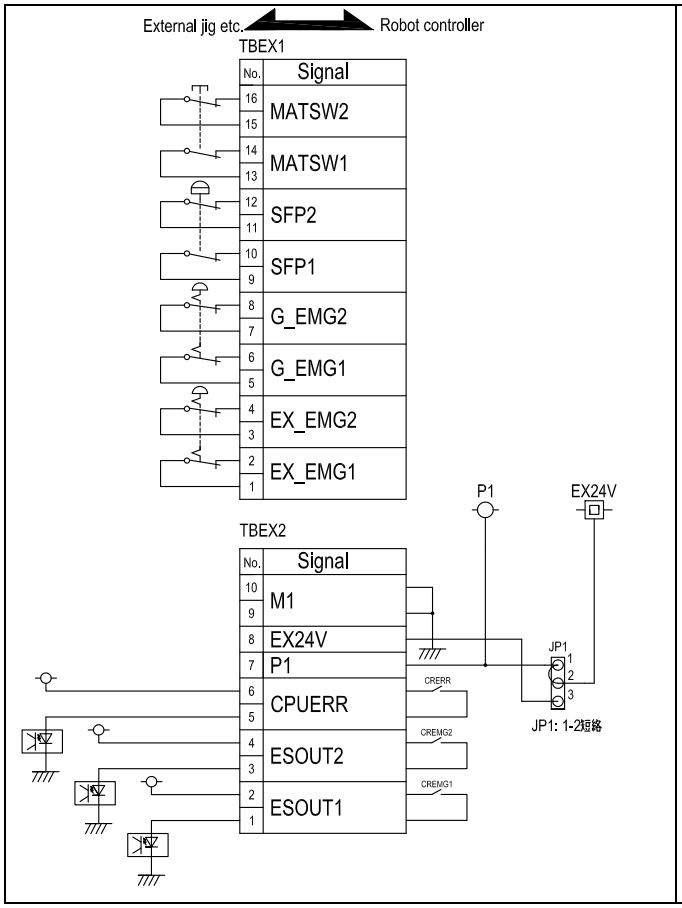
- When using an external emergency stop button, G-STOP input, safety plug or teach enable switch, always double-up on connection points.
  (E.g.: When an external emergency stop button is used: Pin 1-2 and Pin 3-4)
- These signals are ***"NC" (Normal Close)*** signals ("B" contact). If these signals are not connected, the robot cannot move.

INFO.

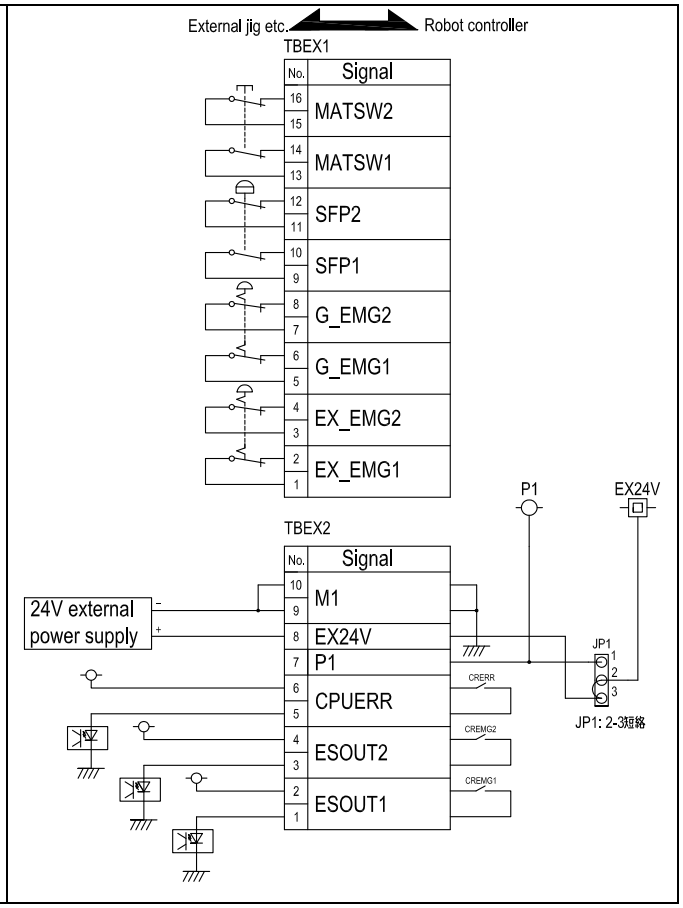
"G-STOP" is a function known as a "protective stop" that protects from dangers occurring in the environment outside of the system when the robot is operating normally.
For details, refer to the section 2.8.6

Terminal block TBEX2 of Sequence board

Pin No	Signal name	Function	Description
10	M1	Ground	By supplying external power (DC24V) between the EX24V and M1 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 the following page.
9			
8	EX24V	External power 24V input	
7	P1	Internal DC24V	Terminal for DC24V – 0V power inside the robot controller. Do not use this terminal outside the robot controller since this is for the internal use only. Also, do not use this terminal when other devices are to be installed.
6	CPUERR	CPU error output – (dry contact)	Dry contact A output terminal to indicate the status of CPU in the robot controller. It turns ON (the contact is closed) when the CPU error occurs.
5		CPU error output + (dry contact)	
4	ESOUT2	Emergency stop output 2- (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 has been designed dual. (The dry contact output has been provided in two individual systems.)
3		Emergency stop output 2+ (dry contact)	
2	ESOUT1	Emergency stop output 1- (dry contact)	
1		Emergency stop output 1+ (dry contact)	



Connection example of TBEX1,2
(DC24V internal power)



Connection example of TBEX1,2
(DC24V external power)

CAUTION

Do not use the P1 terminal outside the robot controller since this is for the internal use only.

2.8.4 Electrical specification of input terminal block

This table shows the power specifications for 1 input signal point.

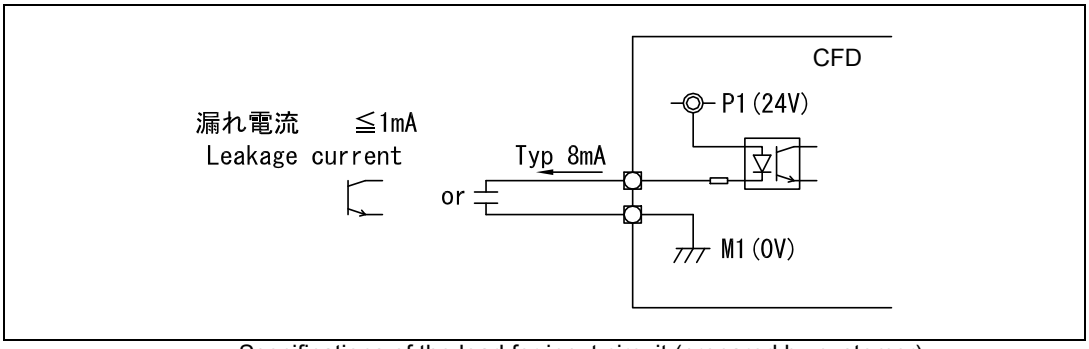
Electrical specifications of input terminal block

Items	Specifications
Input impedance	Approx. 3 kΩ
Input voltage	DC+24V ±10%
Input current	8mA (typ.)

The following shows the input load (customer prepared) specifications.

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

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



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

2.8.5 Electrical specifications of output terminal block

The following shows the power specifications for 1 output signal point.
Prepare the output load that conforms to these specifications.

Electrical specifications of output terminal block

Items	Specifications
Output method	Relay contact
Rated voltage	AC 100 V or DC 30 V
Rated current	1A
Minimum applicable load	DC24V 5mA
Electrical expected life	Min. 10^5 times (1A,100 V AC, 1A,30 V DC, resistive load, at 20 times/min.)

CAUTION

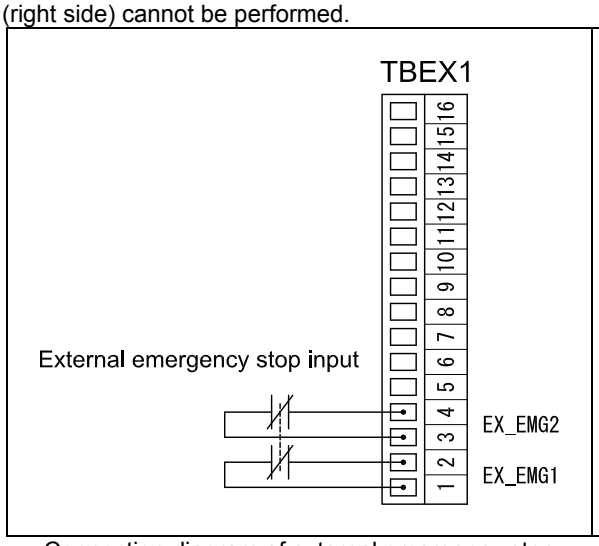
(1) Be absolutely sure to use a surge killer for the load.
(2) Since the value of minimum applicable load depends on the switching frequency, environment conditions, and expected reliable level, be sure to check with the actual load condition before operation.
(3) Electrical expected value is a reference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

2.8.6 Connection procedures on input terminal block

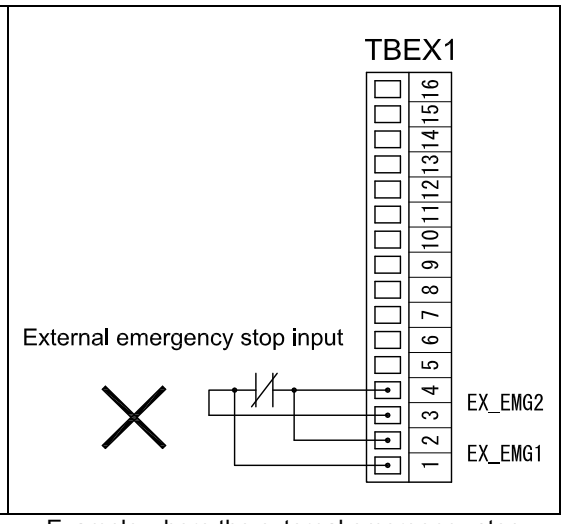
External emergency stop input (TBEX1: 1-2, 3-4)

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. Bear in mind that the connections given in following figure (right side) cannot be performed.



Connection diagram of external emergency stop inputs



Example where the external emergency stop input cannot be performed

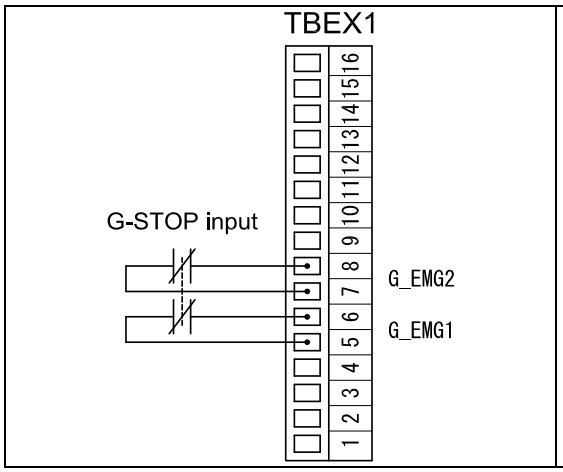
G-STOP input (TBEX1: 5-6, 7-8)

If the G-STOP input signal becomes open in any situation, the robot immediately brakes, and the magnetic switch is disconnected. However, unlike with the external emergency stop input, the motor power is not cut.

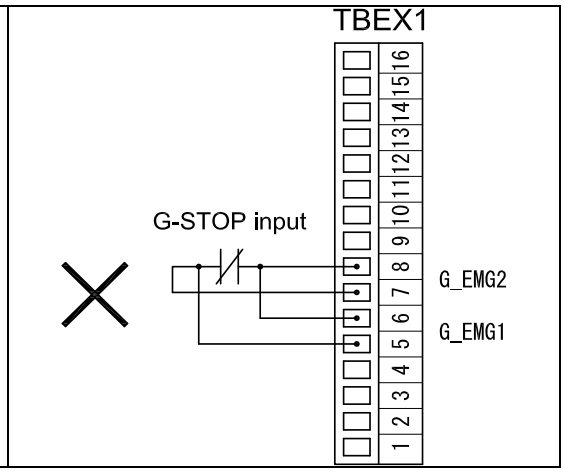
When the "G-STOP Reset" (input signal) of the assigned signal is switched ON and G-STOP signal closed, the magnetic switch is automatically closed, and operation restarts.

2 independent input signals are required to do the same operation. Connect both 5-6 and 7-8 terminals to independent normal close contacts. Please note that connections such as shown in following figure (right side) cannot be made.

Connections to the light curtain are an ideal example of use. If the worker has interrupted the light curtain, the robot (only) is stopped with the motor power ON. When the robot has returned to outside of the light curtain, the servo switches ON automatically, and playback can be continued.



Connection diagram of G-STOP inputs



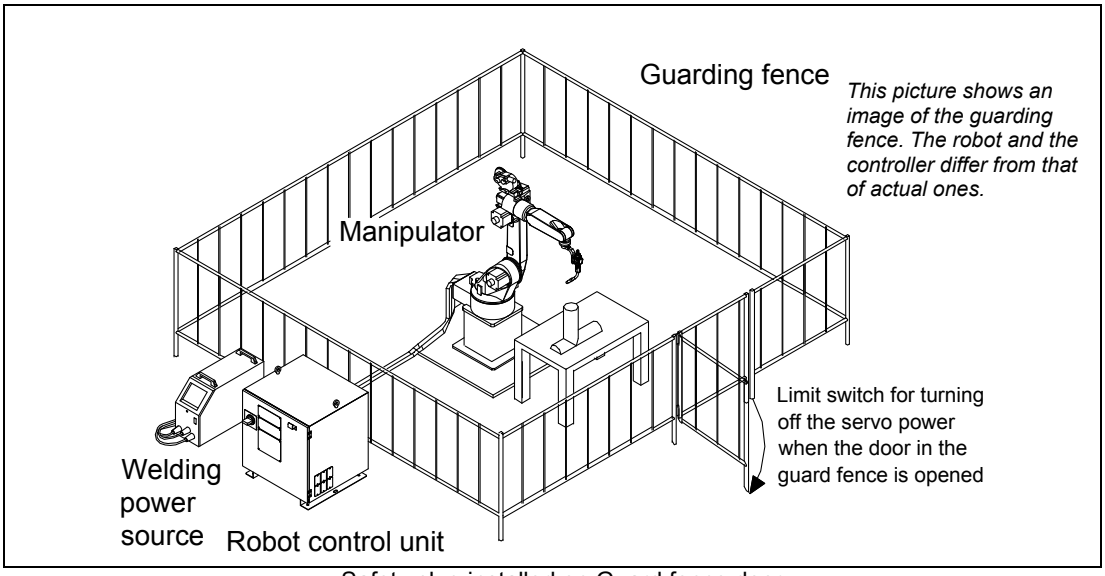
Example where G-STOP input cannot be performed

Safety plug input (TBEX1: 9-10, 11-12)

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 following figure cannot be performed.

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).



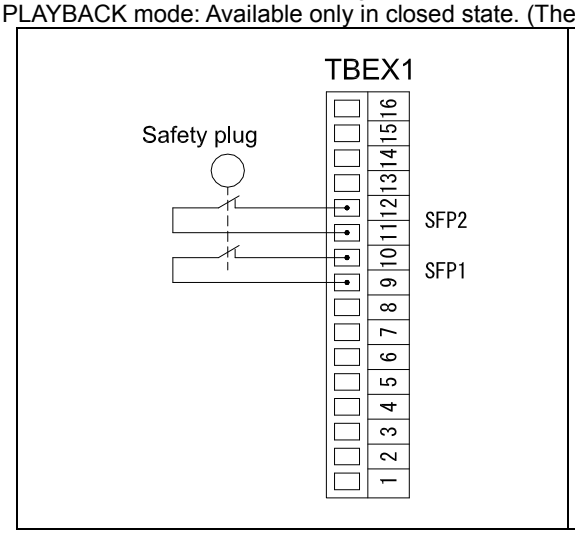
Safety plug installed on Guard fence door

CAUTION

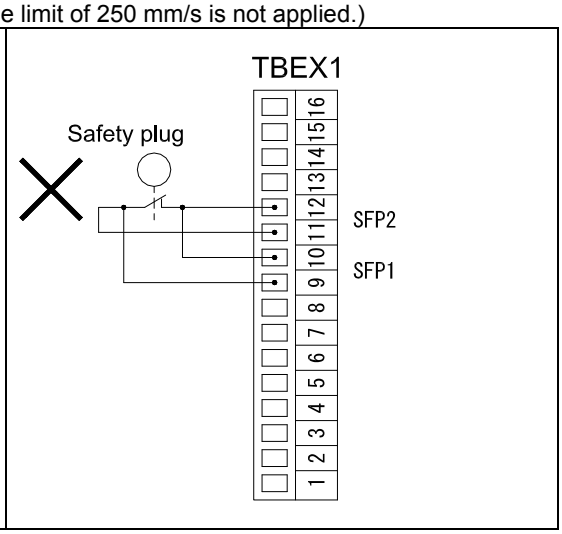
In playback mode, the servo power cannot be switched ON unless the safety plug input is ON. Always connect the safety plug.

[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.)



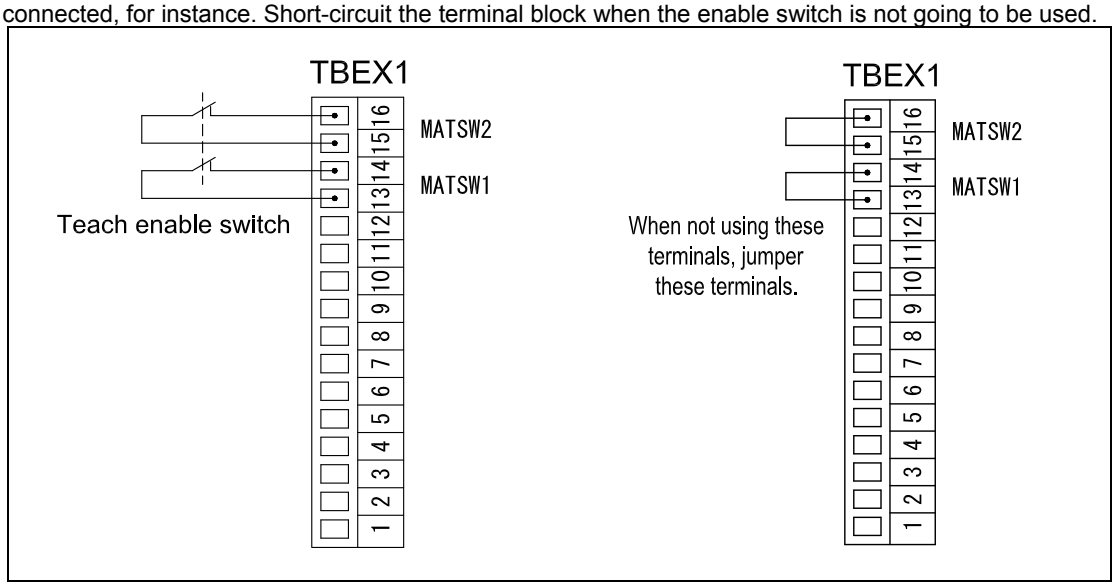
Connection diagram of the safety plug inputs



Example where the safety plug input cannot be connected

Teach enable switch input (TBEX1: 13-14, 15-16)

For the enable switch inputs, input a condition allowing robot operation in the teach mode. A mat switch can be connected, for instance. Short-circuit the terminal block when the enable switch is not going to be used.



Connection diagram of teach enable switch inputs

Connections when the robot controller is used by itself

When the robot controller is not going to be connected to an external device but used by itself, perform the connections shown below. The external emergency stop, G-STOP and teach enable switches are shorted, but connect the safety plug for detecting that the door of the guard fence has been opened to the safety plug inputs.

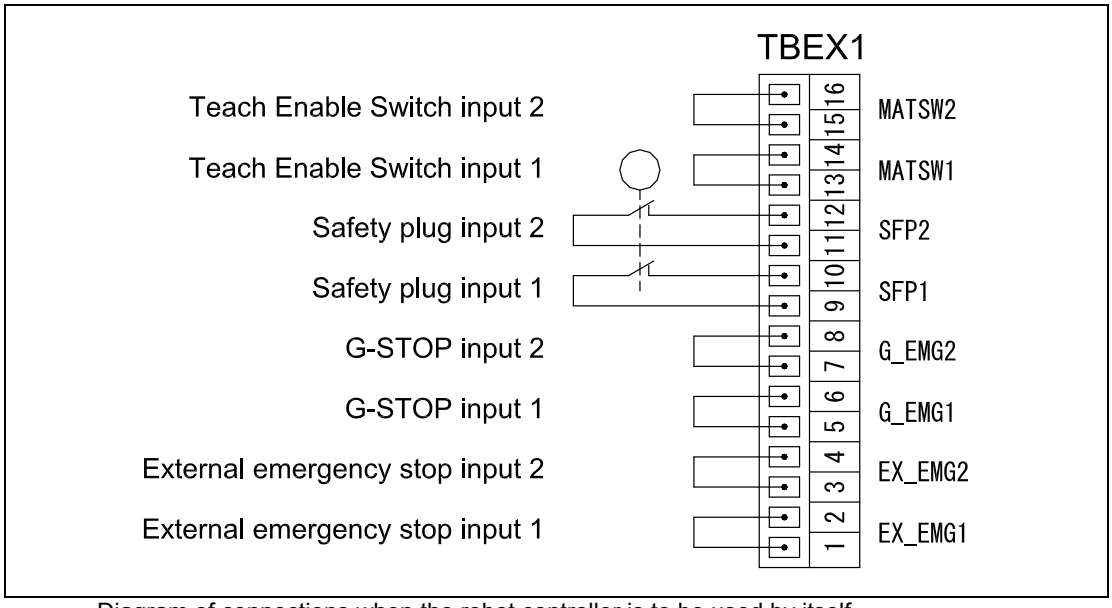


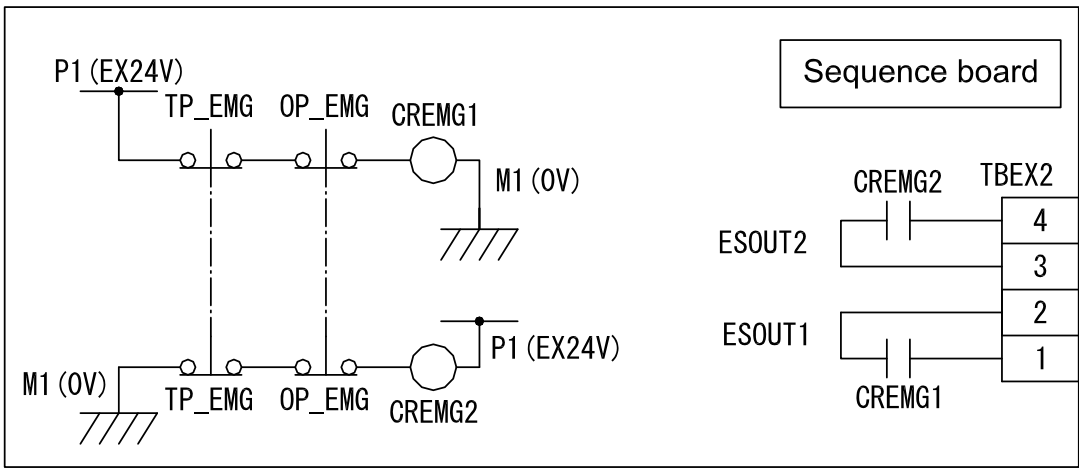
Diagram of connections when the robot controller is to be used by itself

Jumper setting (Initial setting)

Terminal block	Terminal No. to be short-circuited	Remarks
TBEX1	15-16	Enable switch input 2
	13-14	Enable switch input 1
	7-8	G-STOP input 2
	5-6	G-STOP input 1
	3-4	External emergency stop input 2
	1-2	External emergency stop input 1

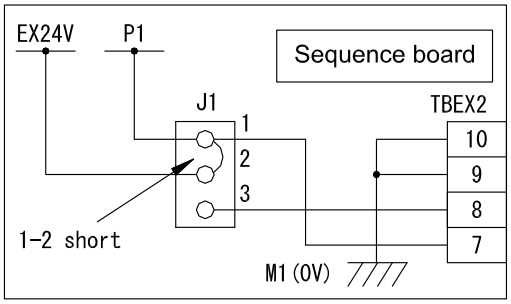
2.8.7 Emergency stop output connection (TBEX2 : 1-2, 3-4)

Internal electrical circuit of Emergency stop output is shown in following figure.

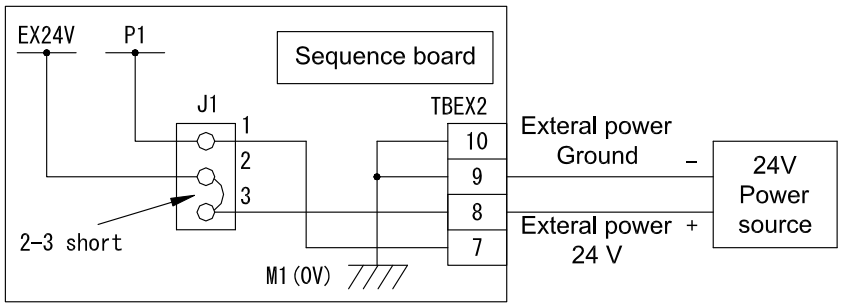


Internal electrical circuit of Emergency stop output

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 power supply of the controller is OFF, supply external power supply from TBEX2, and change the setting of the above jumper (J1)



In case that emergency stop circuit is used by internal DC24 V (Initial setting)



In case that emergency stop circuit is used by external DC24 V

Chapter 3 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.

3.1 How to read “Chapter 3 Setup”

In this chapter, 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

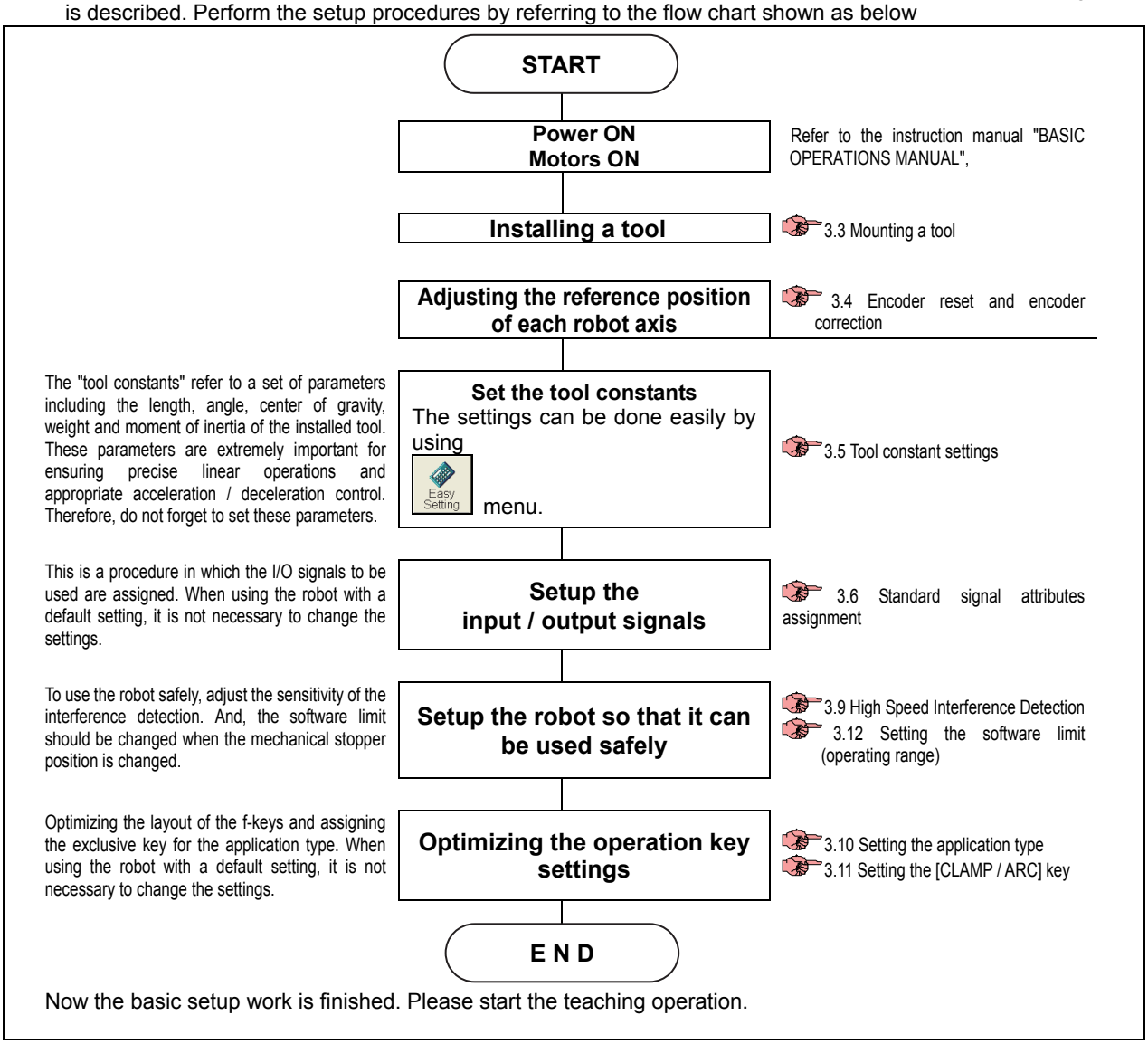


Fig. 3.1.1 Overview of basic setup work

3.2 Configuration

The mechanical system configuration (such as the mechanism model settings, unit configuration definition, encoder correction settings, and operating range settings) and operability configuration (such as the display language settings, application settings, and function key layout) have been shipped from the factory in the optimum condition for the status of the system purchased.

Since there is normally no need for customer to change these settings, simply proceed to the next section.

3.3 Mounting 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 material handling gripper or sealing nozzle gun.

3.3.1 Mounting a tool

For example, install the tool onto the tool flange surface.

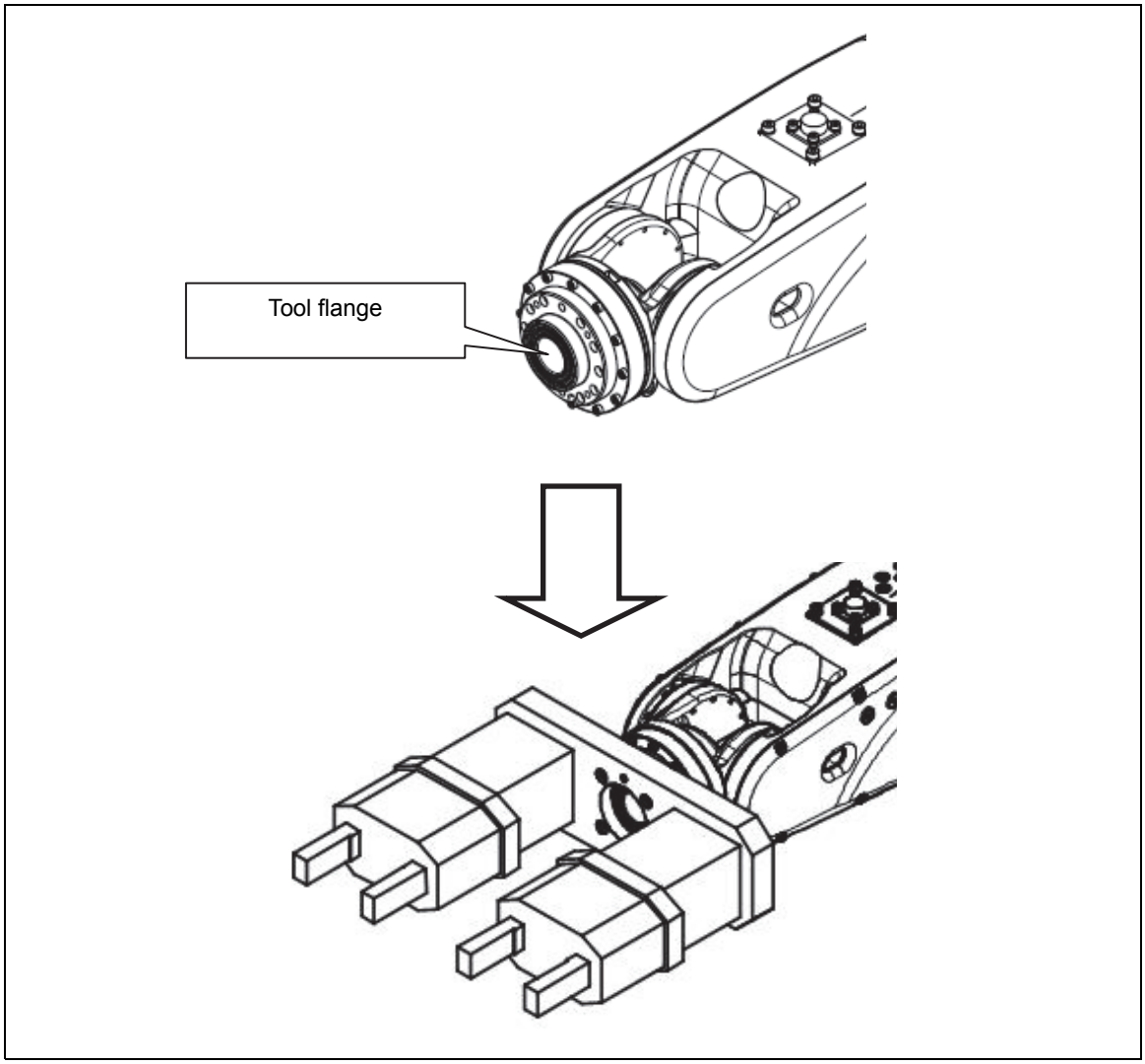


Fig. 3.3.1 Installing a tool

The flange surface (mechanical interface) differs from the robot type.
For details, refer to the instruction manual of the robot.
("MANIPULATOR MANUAL")

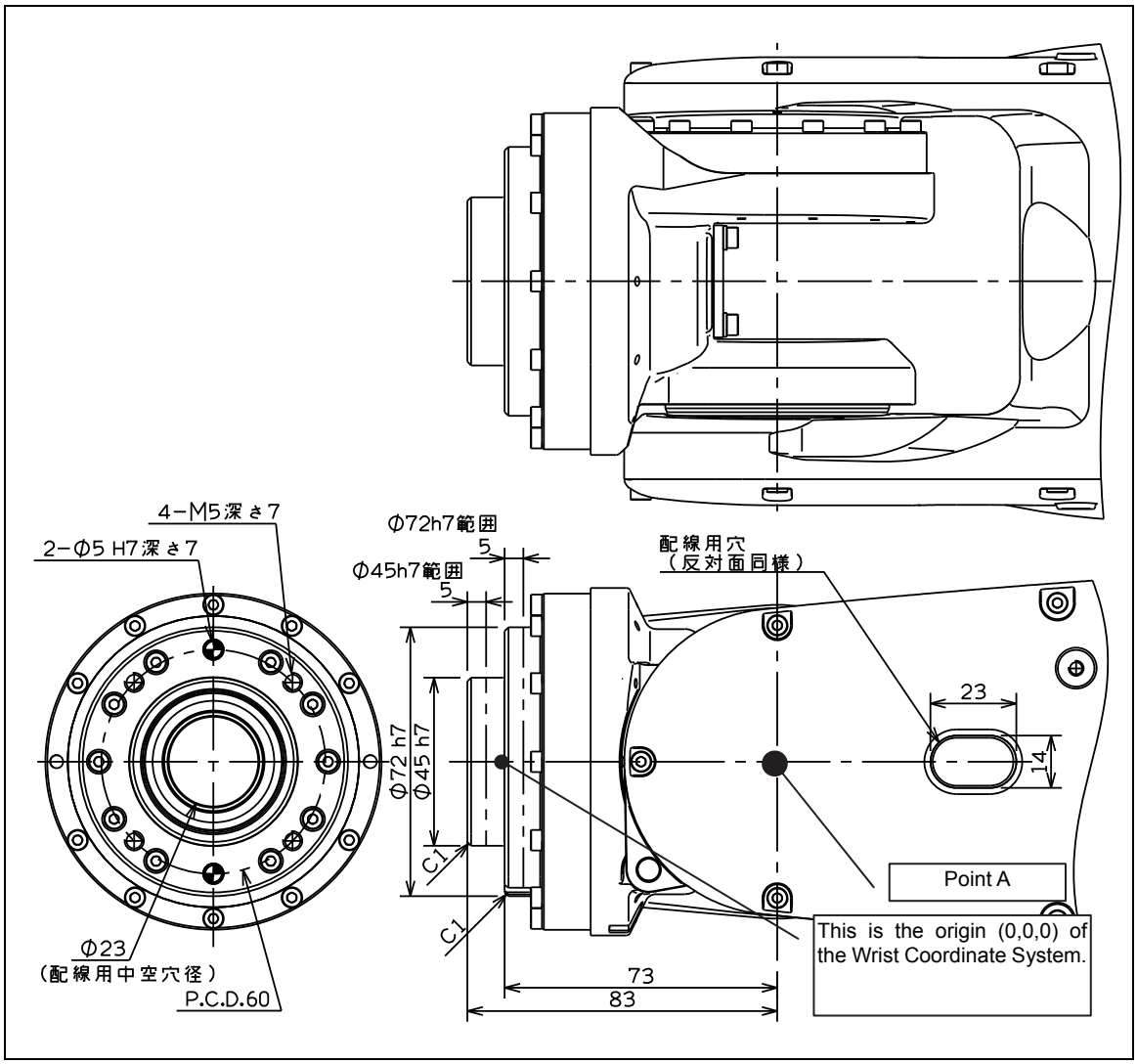


Fig. 3.3.2 Detailed outline drawings of tool installation area (example of MZ07)

CAUTION

- The depth to which the tool (end effector) 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.

- However, if the bolts are too short or the tightening torque is not strong enough, the tool may fall down. Please be careful.

INFO.

- When using a standard gripper (option), please refer to the following instruction manual also.
"CFD CONTROLLER TECHNICAL DOCUMENT 1" (TCFEN-155)

- Because of the options like "Wires clamp" (e.g. "OP-W3-**") etc., the dimension or the angle of the tool installation flange may change. Please check the details by referring to the instruction manual ***"TECHNICAL DOCUMENT 1"***.

3.4 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 mounting 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

- Perform encoder correction for all axes after mounting 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.

- 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.

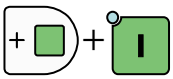
Concerning the detailed procedures of the encoder reset and the encoder correction for the additional axes, please refer to the respective instruction manuals.

IMPORTANT

Reference position (zeroing position) is the axis position where “Zeroing pin” or “Zeroing block” 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 MANUAL" for detail.

Moving to the Mechanical reference pose and selecting the menu items

1 **Select the TEACH mode.**



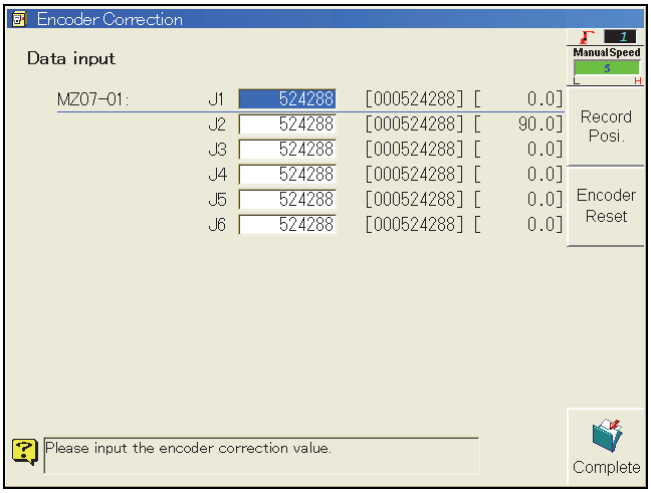
2 **Turn on the servo power supply.**

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")
>>In case of MZ07 robot, refer to the Fig. 3.4.1

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

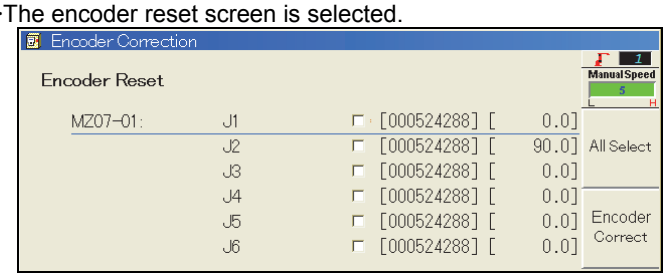
4 Open <Constant Setting> - [3 Machine Constants] - [4 Encoder Correction].

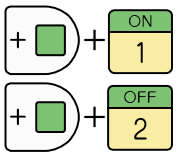
Now proceed with the encoder reset and encoder correction operations. (These are described on the next and subsequent pages.)
The screen that appears when the menu is selected is the screen on which the encoder correction is performed. The encoder correction or encoder reset operation is selected on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



3.4.1 Encoder Reset procedure

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

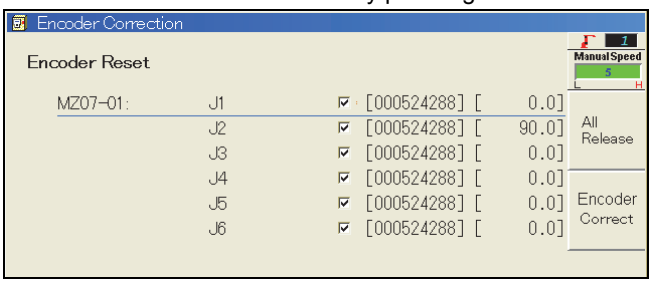




2 To reset a specific axis only for replacing a motor, for instance, select the axis, and press [ENABLE] + [1].
>>A check mark appears for the selected axis.

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.)

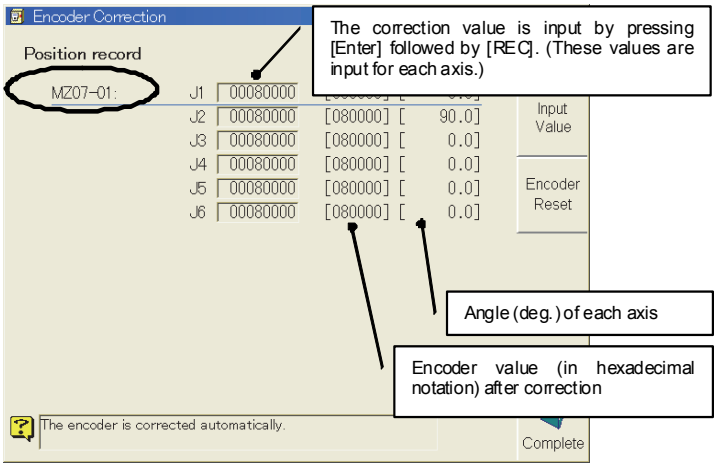
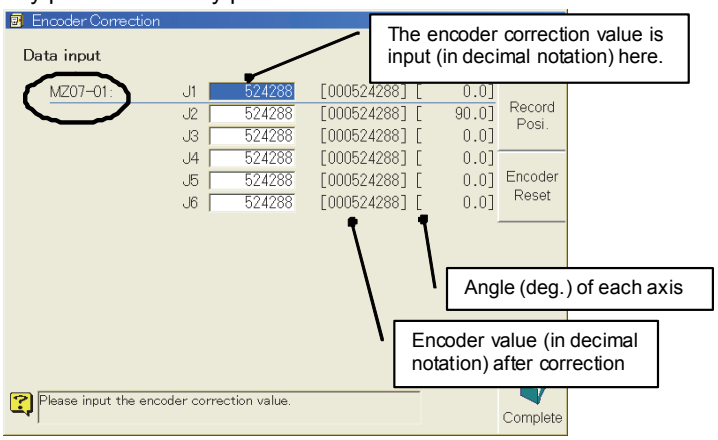
>>If the encoder reset is successfully finished, a message to show the result will appear.

3.4.2 Encoder Correction procedure

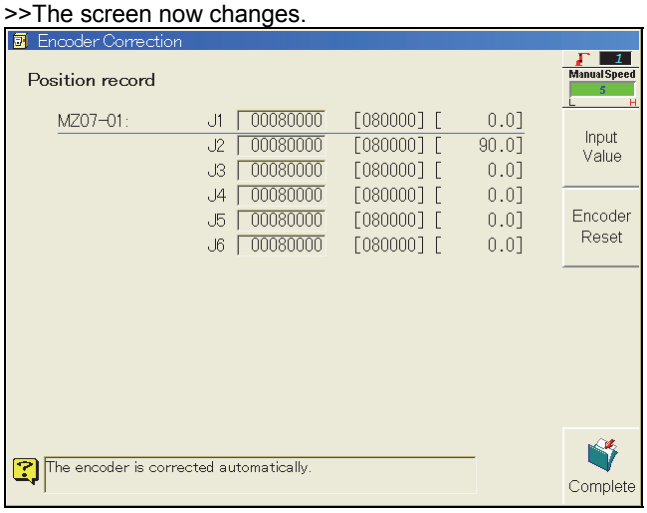
Encoder Correct

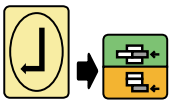
1 Upon completion of the encoder resetting, proceed with the encoder correction.
Press f9 <Encoder Correct>.
>> The screen which appeared immediately after [3 Machine Constants] [4 Encoder Correction] were selected is restored.

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 safe corridors. If this procedure is omitted, operator may be caught or sandwiched 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.

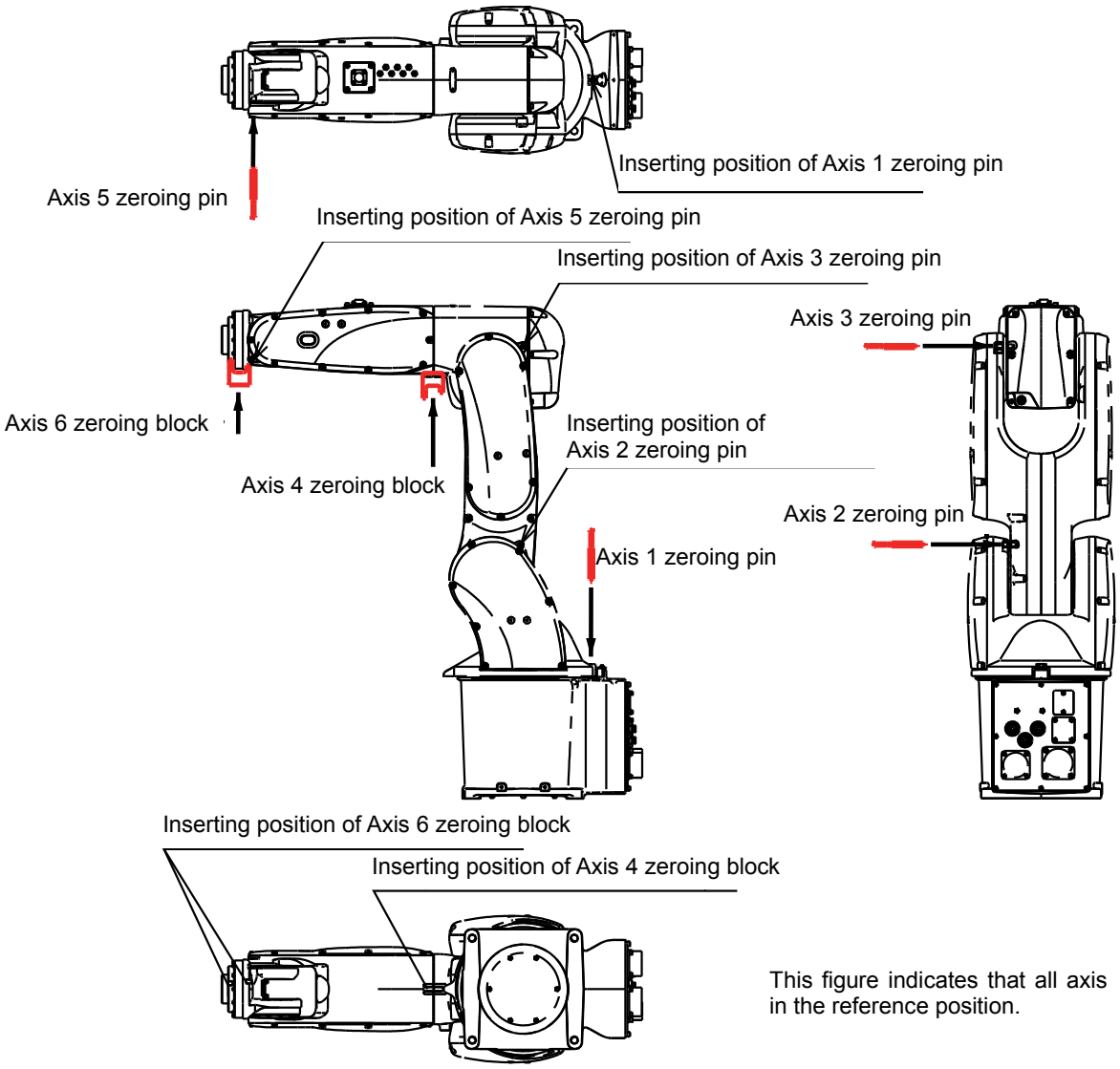


Fig. 3.4.1 A Pose to insert the zeroing pin (An example of MZ07)

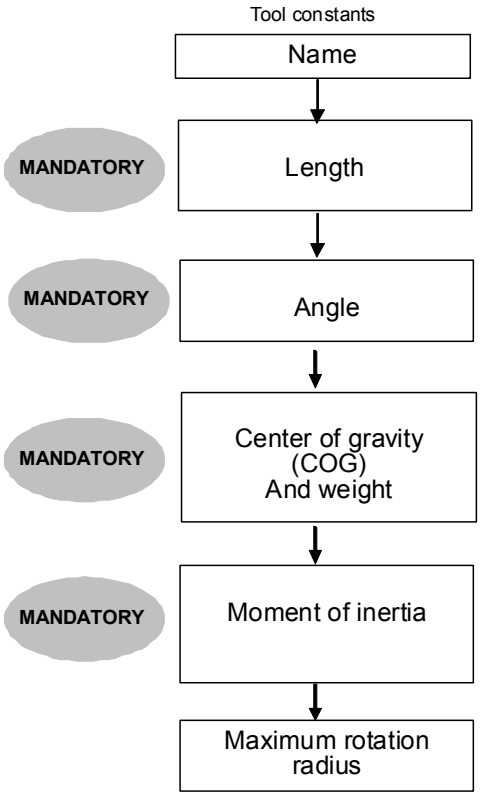
3.5 Tool constant settings

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.

CAUTION

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 3.5.1 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 length up to the tool tip in the TCP coordinate system (X, Y and Z components of the tool tip). 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 for setting the inclination of the tool tip in the TCP coordinate system using the 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 for setting the tool's center of gravity position in the TCP 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 for setting the moment of inertia around the center of gravity in the TCP
coordinate system using the X, Y and Z components. 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.

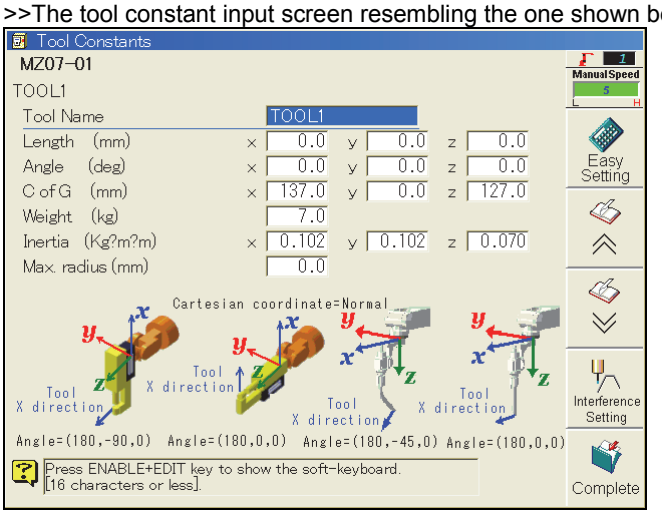
This constant is the max. radius of the tool. It is used to check the territory, etc.

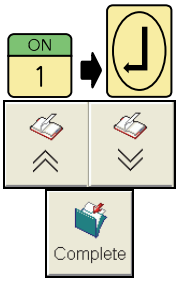
Common operating procedure for setting tool constants

(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 resembling 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.

3.5.1 Tool name

With an application which involves the use of a multiple number of tools, the parameters become more comprehensible if the name or model, for instance, is 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 alphanumerics and symbols.
Refer to the instruction manual;
"CFD CONTROLLER INSTRUCTION MANUAL: BASIC OPERATIONS MANUAL" (TCFEN-160)

3.5.2 Tool length

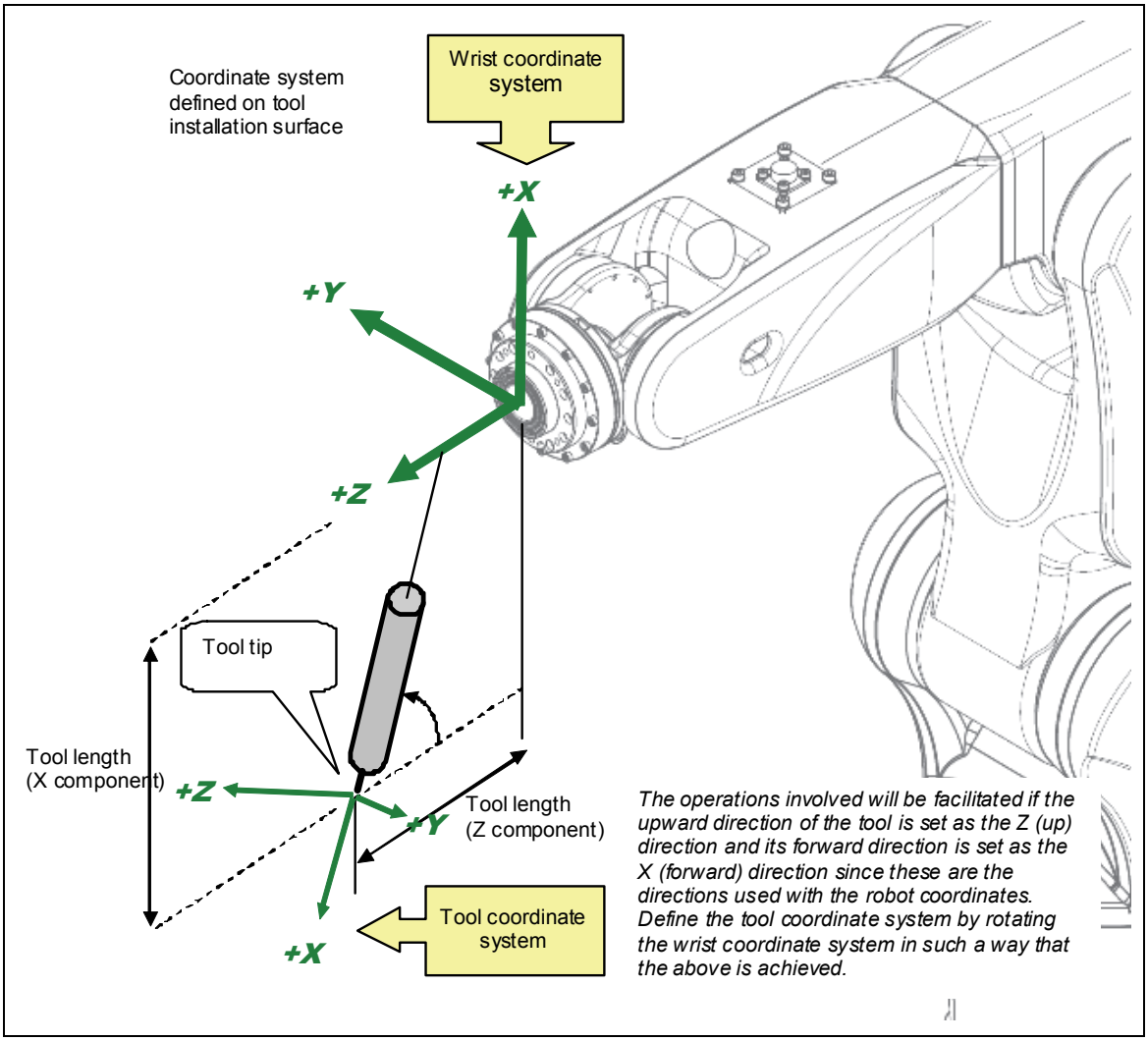


Fig. 3.5.1 Illustration of tool length and angle

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.

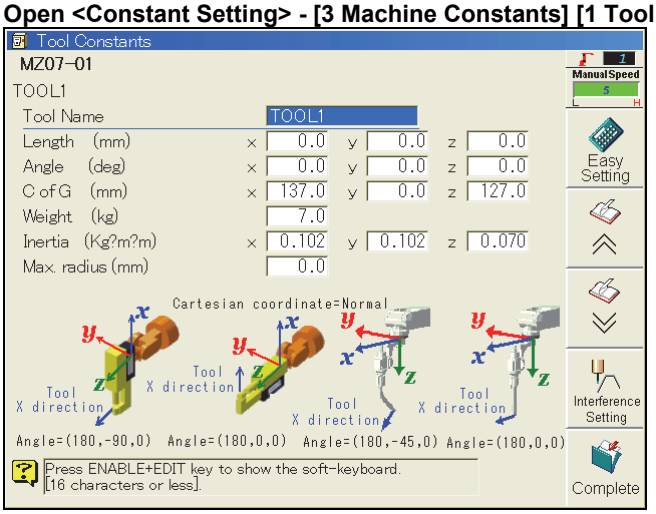
For the **tool length automatic setting function** described next to be used, the basic teaching and playback check jobs must be performed. Since these jobs cannot be done if the "BASIC OPERATIONS MANUAL" has not yet been read, do not set the tool length but use the initial setting as is and continue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

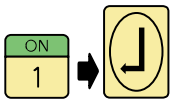
Setting the tool length manually (numerical value input)

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

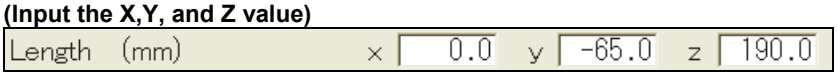
1 **Select the teach mode.**

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)



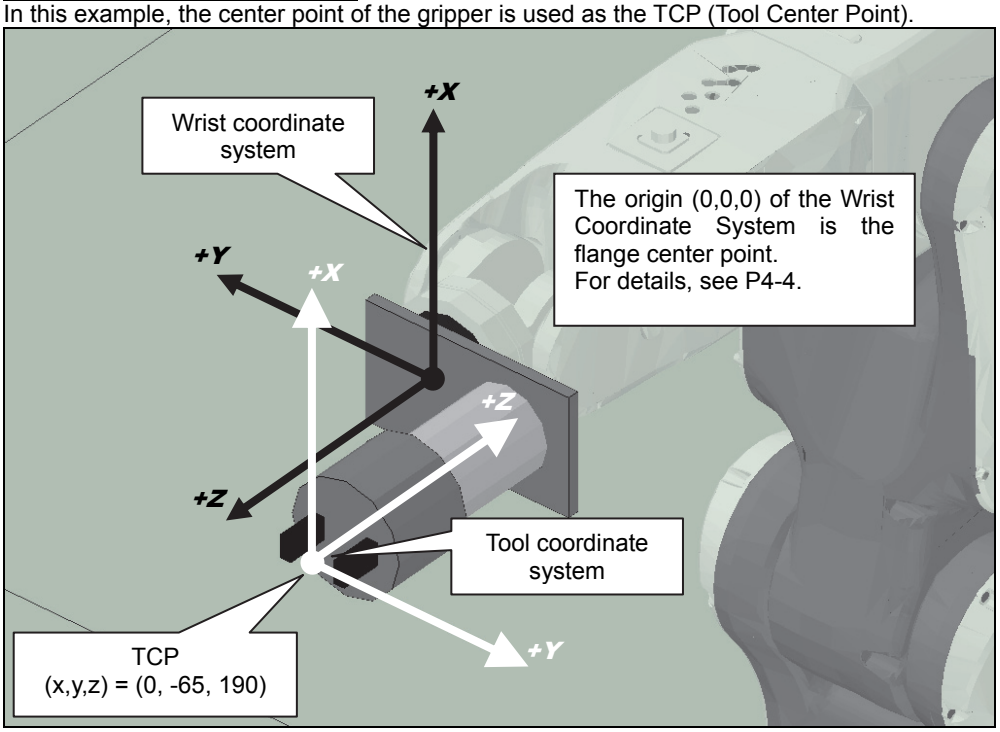
(See the example in the next page)

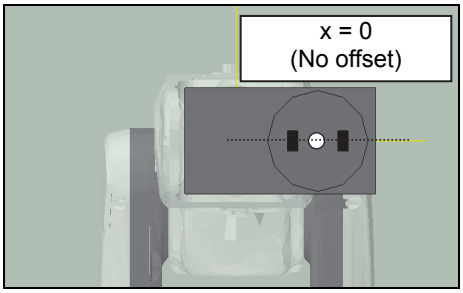
4 **Upon completion of the settings, press the <Complete> key. The settings are now saved in the constant file.**
>>Operation returns to the machine constant menu screen.

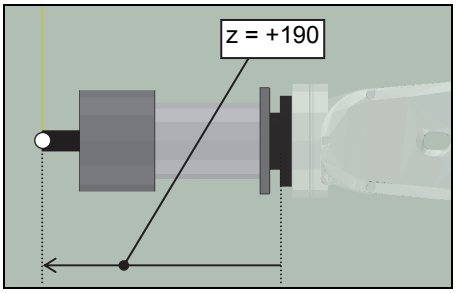
(NOTE) The “Complete” operation (=writing operation to the internal memory) cannot be executed if the Motor Power Source Circuit is ON. Turn the Motor power source circuit OFF by pressing the [EMERGENCY STOP BUTTON] before pressing the <Complete> key.

Tool length setting example (1)

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



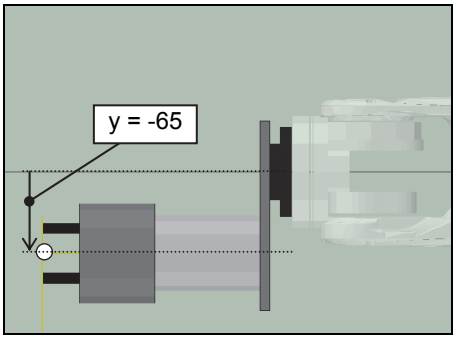




Based on the “Wrist coordinate system”, the TCP position (=Tool length) is;
(x, y, z) = (0, -65, 190)

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])

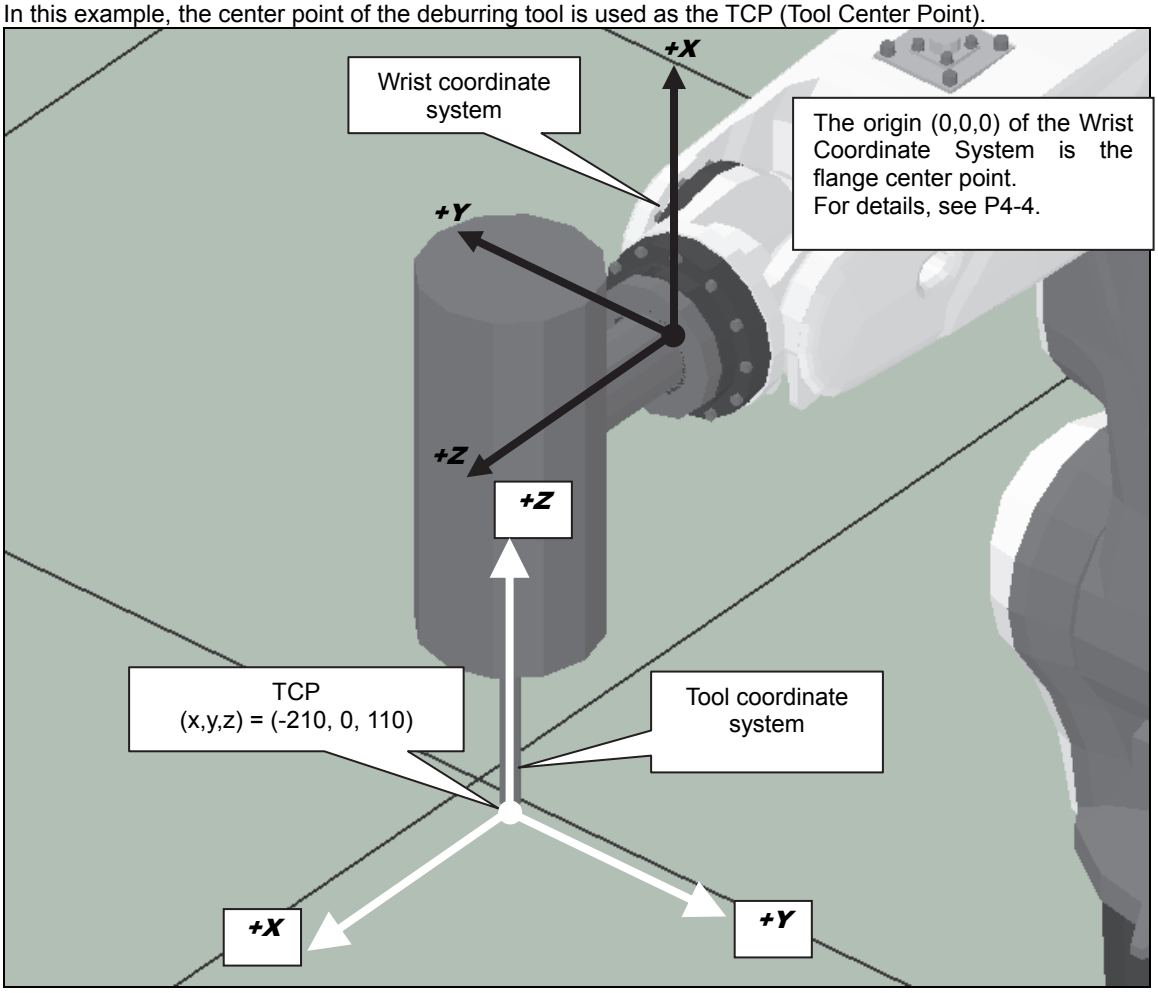
Length (mm)	x	0.0	y	-65.0	z	190.0
Angle (deg)	x	180.0	y	0.0	z	0.0

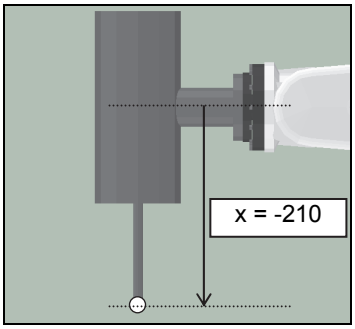


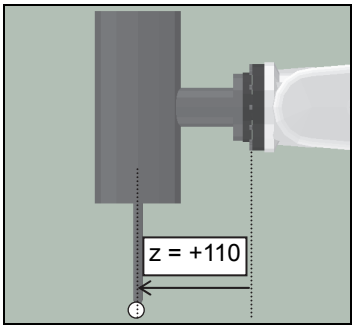
Normally, accurate motion path of the TCP is not required for most of the handling application. (Only the accurate position repeatability is required) So the setting accuracy of the TCP coordinates does not matter. However, if the application requires accurate motion path, please set the TCP position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

Tool length setting example (2)

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



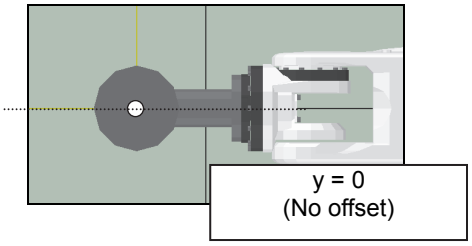




Based on the “Wrist coordinate system”, the TCP position (=Tool length) is;
(x, y, z) = (-210, 0, 110)

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])

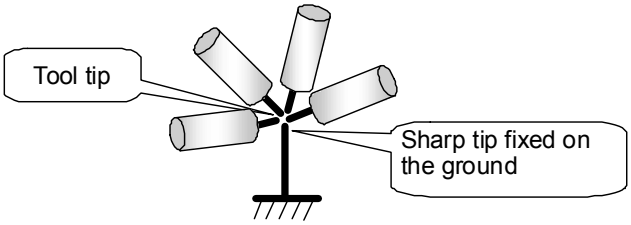
Length	(mm)	x	-210.0	y	0.0	z	110.0
Angle	(deg)	x	180.0	y	-90.0	z	0.0



Setting the tool length automatically

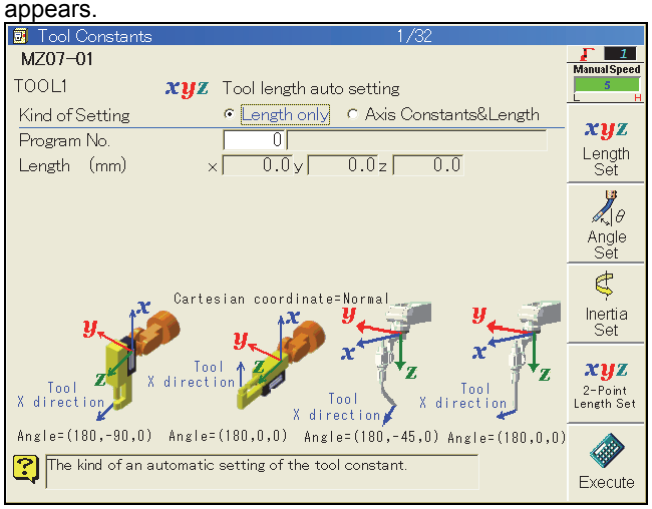
Although one program for calculating the tool length must be taught, the tool length can then be set automatically simply by taking this preparatory step.
It does not matter whether the tool angle has already been set or not.

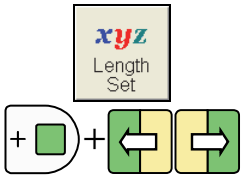
1 **First, the programs for setting the tool length automatically must be taught. Teach the kind of programs where the tip of the installed tool (install a tool with a sharp tip here as well) is aimed in a number of different postures at a sharp tip which has been secured to the ground. The required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

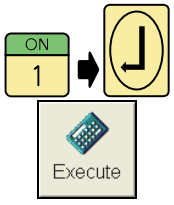
2 **On the tool constant setting screen for the desired tool number, press the <Easy Setting> key.**
>>The tool length automatic setting screen such as the one shown below now appears.





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

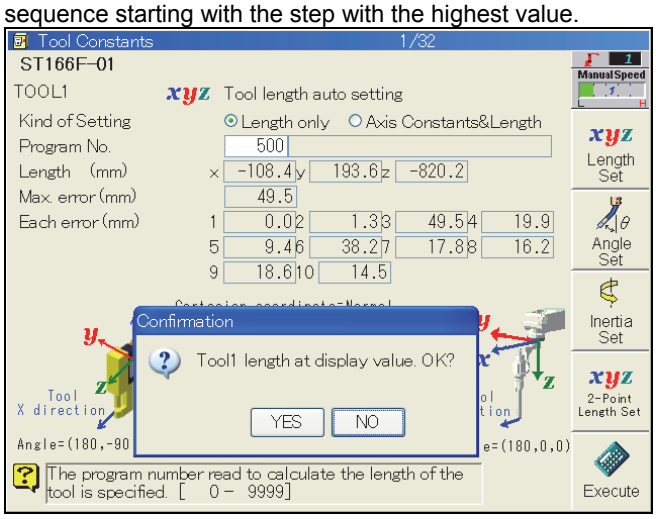
4 **Select the setting type. Select "Axis Constants & Length" or "Length only" using the [ENABLE] and [Left/right cursor] keys.**
Normally, "Length only" is selected.
Select "Axis Constants & Length" only when more accurate length setting is required. In this case, the axis constants of J2, J3, J4 and 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.**

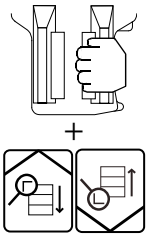
6 **Press the <Execute> key.**

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.

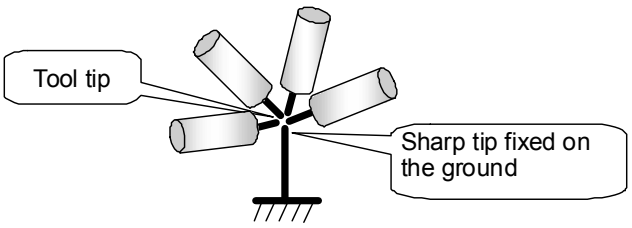


If satisfactory results have been obtained, select [Yes] on the pop-up window, and press [Enter] key.
>>At this stage, only the display is updated, and the data is not yet stored in the constant file.

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.



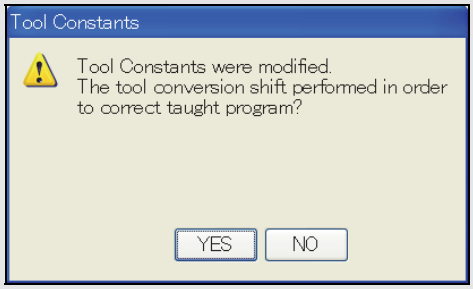
9 **Upon completion of the settings, check them.**
Exit the constant menu and try check go/back of program taught in 1.



If, unlike the movements which resulted when the program was first taught, 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.

CAUTION

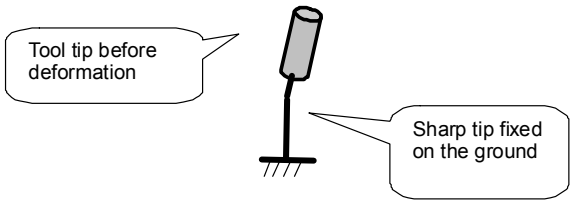
When pressing <Complete> key, following message will appear. If programs are already taught and these are not to be modified, please select [NO].



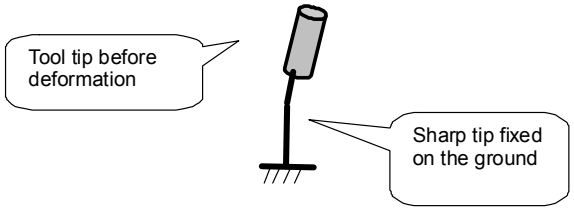
Tool Length Automatic Setting (2-point tool length setting)

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.

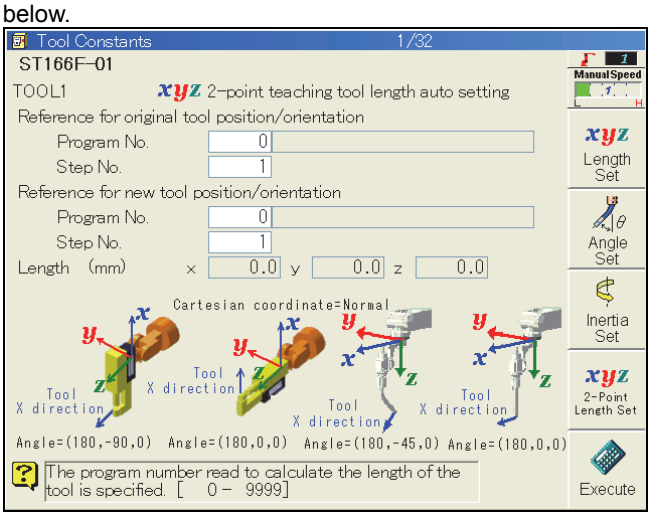
1 **First, it is necessary to teach the task program with the tool before deformation. Carry out teaching (1 step) the task program which the attached tool tip (to which a sharp end portion is attached too) is likely to target, to the sharp end fixed to the ground.**



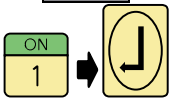
2 **Next, it is necessary to teach the task program with the tool after deformation. Carry out teaching (1 step) the task program in the same manner as in the above 1.**
>>Set the tool posture same as that taught in the above 1.



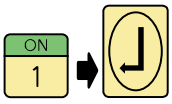
3 **In the tool constant setting screen of the desired tool number, press the <Easy setting> key.**
>>The 2-point teaching tool length automatic setting screen is displayed as shown below.



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.**

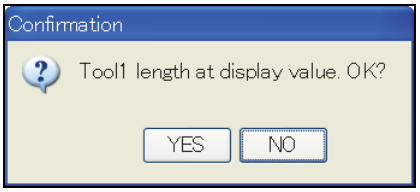


6 **Move the cursor on the step of the reference point before conversion, and input the step number prepared in the above 1 (for example, No.1), and press [Enter] key.**

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.**

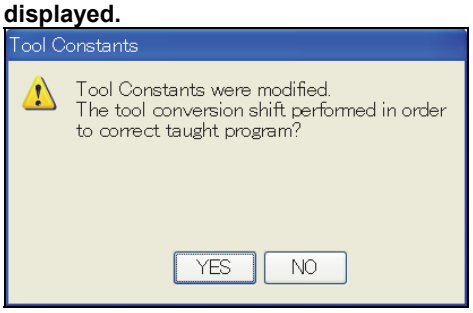
9 **The tool length is calculated, and after a while, the result is displayed as shown below.**



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.
page3.5.7『Tool 』

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

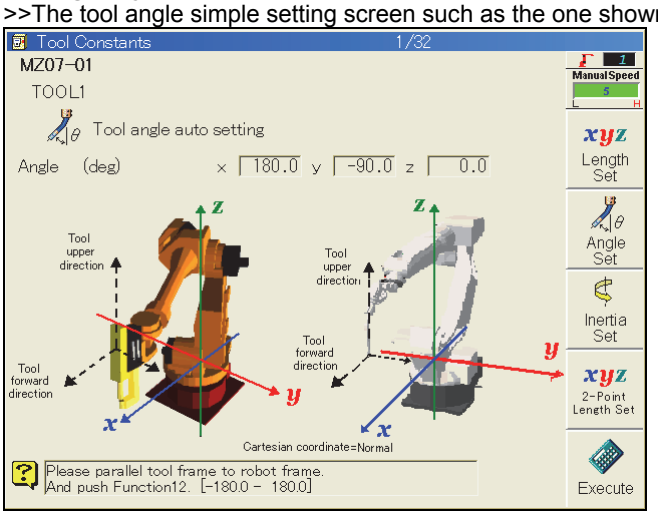
3.5.3 Tool angle

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 is referenced only by the operation direction when manual operations are performed with the tool coordinate and by [Service: Program Conversion: XYZ shift]. Since all other operations and the path used during playback are not affected in any way, the initial setting (0 degrees for all directions) may be used as is.

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

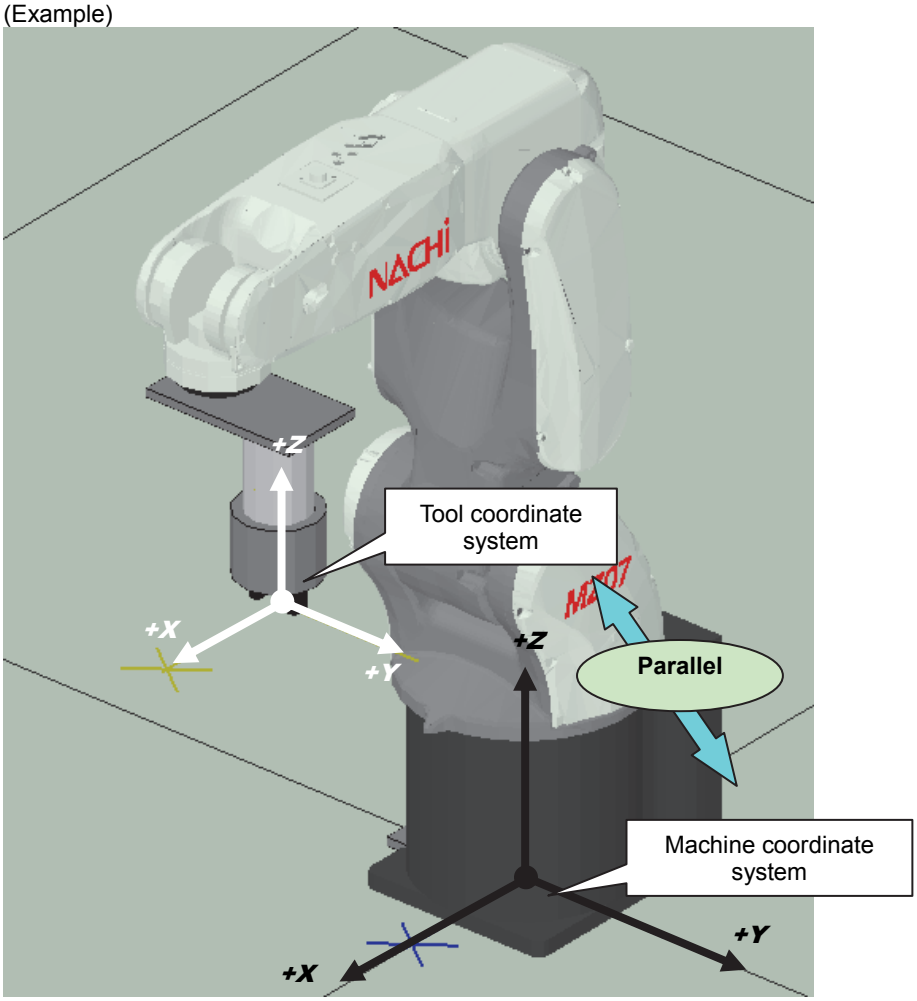
Simply setting the tool angle

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.



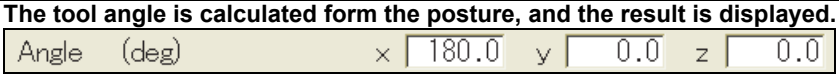
2 **If any other screen has appeared, press the <Angle Set> key.**

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)



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.

3.5.4 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.

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 were to have 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.

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 has not yet been read, 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.

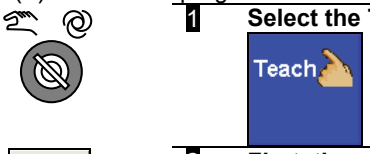
Setting the center of gravity (COG) and weight of tool automatically

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.

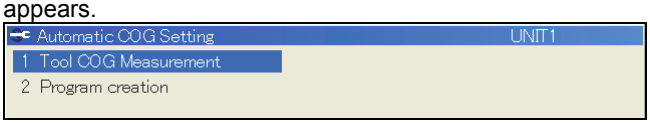
For this procedure, the operator must be qualified as an ***EXPERT*** or above.
page3-47『3.7Concerning the qualifications of the operators』

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

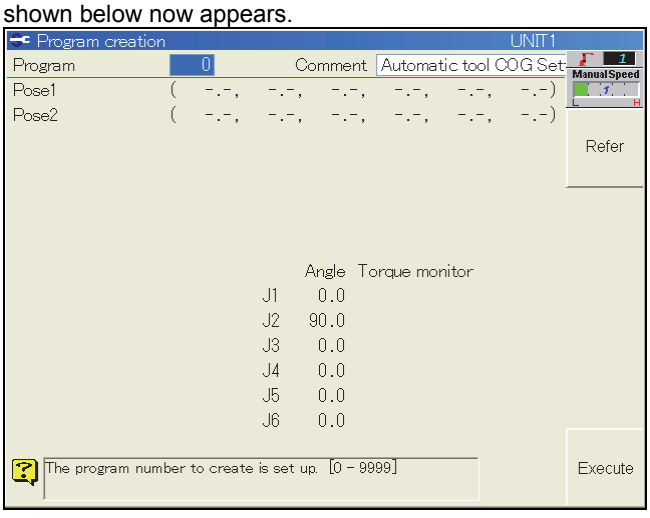
1 **Select the TEACH mode.**

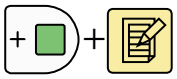


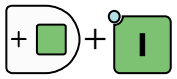
2 **First, the program for the center of gravity (COG) and weight of tool setting function must be taught. Select [Automatic COG Setting] from <Service Utilities>.**
>>An automatic center of gravity setting screen such as the one shown below now appears.

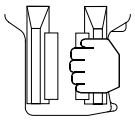


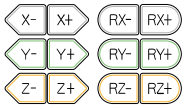
3 **Select [Program creation] from the menu items.**
>>The program creation screen for the auto tool load center setting such as the one shown below now appears.





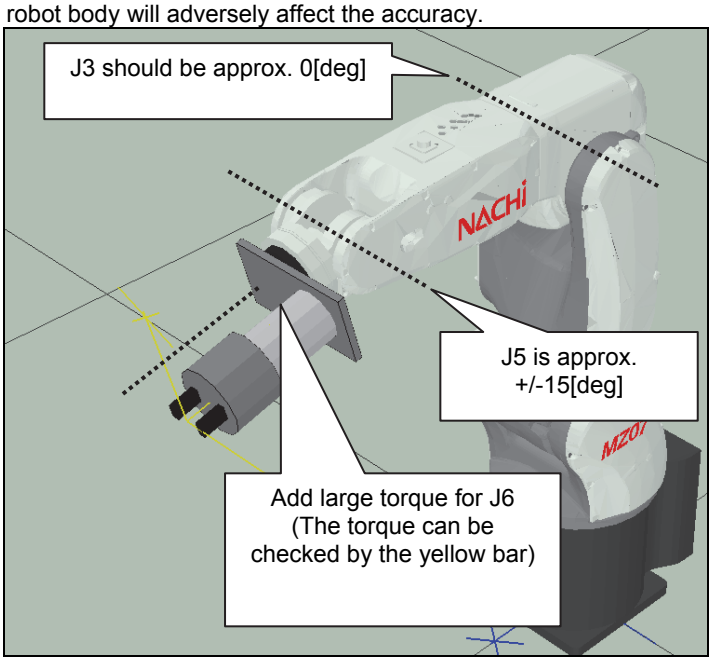






4 **First, align the cursor with the program No., input here the number of a program which is not currently being used, and press the [Enter] key.**
>>This is the number of the program which will now be created for automatically setting the center of gravity (COG) and weight of tool. An unused number 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 may be assumed for the J1 and J2 axes. 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.

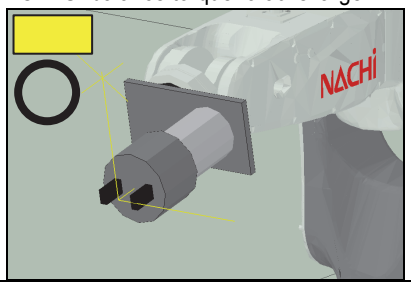


J3,J5,J6 torque bar should be long

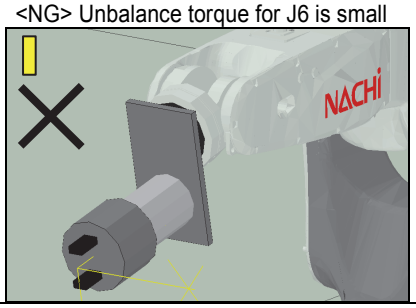
The Torque monitor (bar graph) displays the torque as a ratio to the stalling current of each axis motor. The higher is this ratio, the greater will be the unbalanced torque which is applied and the better suited will be the posture to the automatic center of gravity (COG) and weight of tool settings.

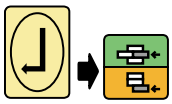
(Supplement for J6 axis)
If the COG (center of gravity) of the tool is not on the rotational center axis of the J6, please use the posture like the following picture. If the COG in on the rotational center axis, the angle does not matter.

<OK>Unbalance torque forJ6 is large

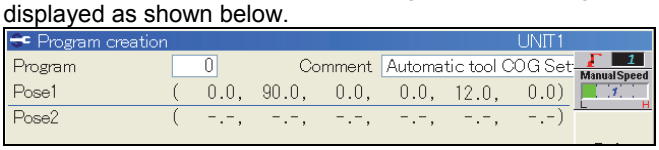


<NG> Unbalance torque for J6 is small

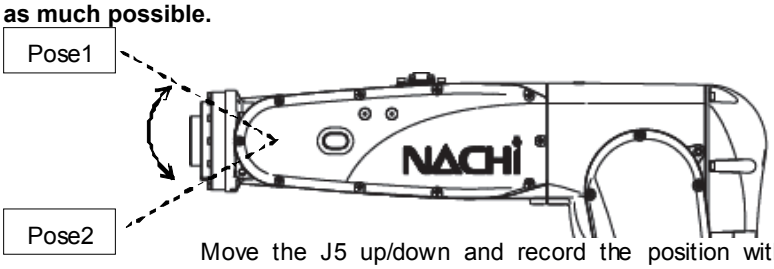




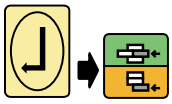
6 **Align the cursor with the Pose 1 field, and press the [Enter] key and [O.WRITE/ REC] key.**
>>The first posture (Pose 1) is now registered. The angle data loaded for the axes is displayed as shown below.



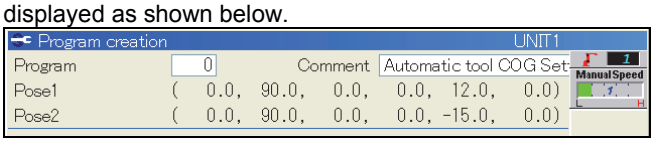
7 **Next, make a major change to the posture. At this time, change the wrist posture as much possible.**



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



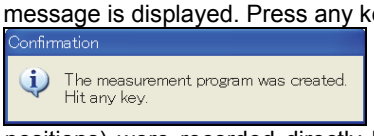
8 **Align the cursor with the Pose 2 field, and press [Enter] key and [REC] key.**
>>The first posture (Pose 2) is now registered. The angle data loaded for the axes is displayed as shown below.



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

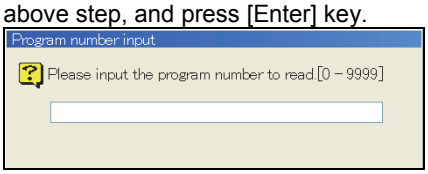
>>Upon completion of the automatic generation of the program, the following pop-up message is displayed. Press any key.



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.

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

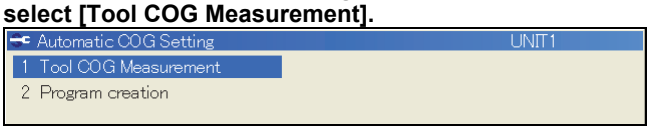
14 **Finally, measure the center of gravity (COG) and weight of the tool.**
"The program for measuring the center of gravity (COG) and weight of tool" which was created before must now be executed.

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

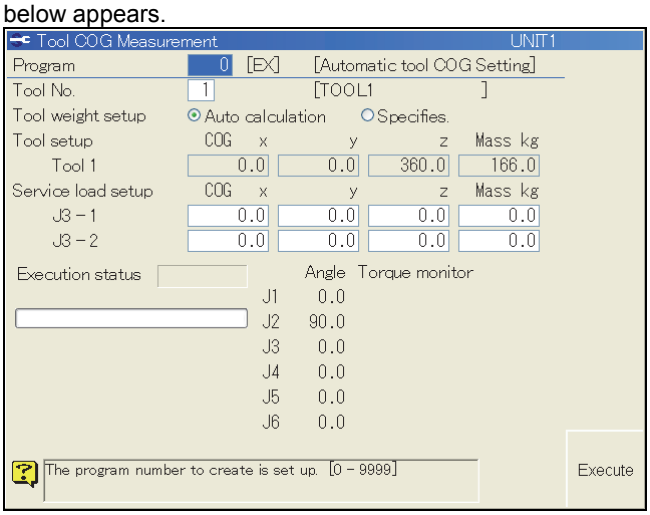
(Execute the measurement in the teach mode)
It is possible to execute this measurement function in the teach mode also.

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

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.

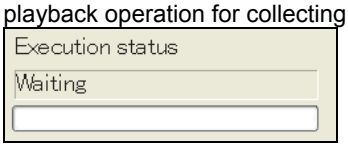


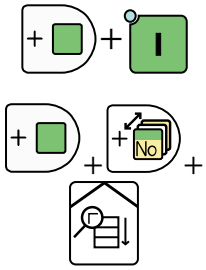
16 **Input the number of the program for measuring the center of gravity (COG) and weight of tool in the "Program" item.**
Input the tool number (1 to 32) to be measured in the "Tool No." item.
>>When the tool number is input, the center of gravity position (mm or inches) and weight (kg) of that tool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

17 **If the tool weight is already known, 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>.**

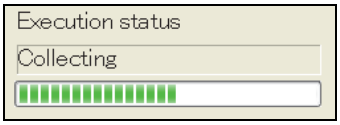
18 **When J3 axis carries a load such as a valve box and its center of gravity position and weight are known, input up to two of these values in the <Service load setup> field.**
>>If the service load is not known, there is no need to set it. The center of gravity (COG) and weight of tool setting function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

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.





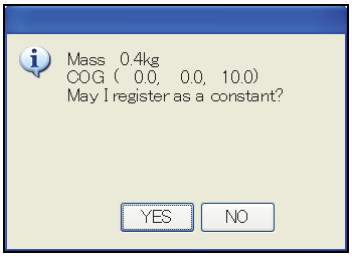
20 **Turn the motor power source circuit ON and start the program.**
>>The program whose number was specified in 16 now starts. The operating speed is the low safety speed. While the current data is being collected, the "Collecting" appears as the execution status, and the progress made is indicated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

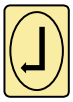


(In case of Playback mode)
>>The playback operation stops automatically after one cycle.

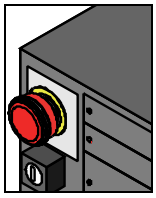
(In case of Teach mode)
Keep pressing the check go key until the program reaches its end step.
When the program stops in halfway, restart the operation from the Procedure 14.

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]

3.5.5 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.

CAUTION

Before using this function, the tool weight and 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

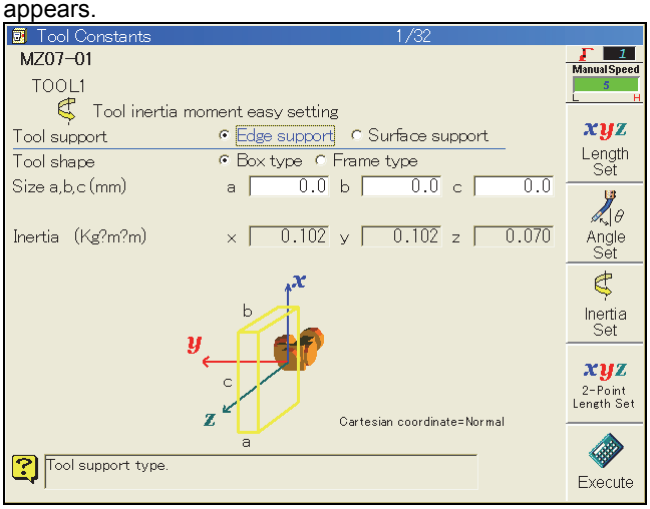
For the automatic inertia setting procedure, the operator must be qualified as an ***EXPERT*** or above.
"3.7 Concerning the qualifications of the operators"

There are 3 methods to set the moment of inertia.
Select the best method by referring to the table below.

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. • 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

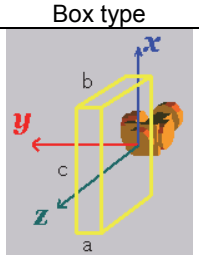
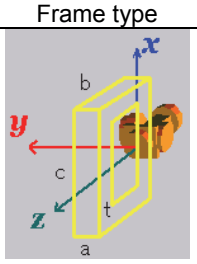
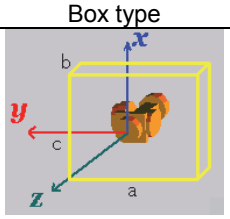
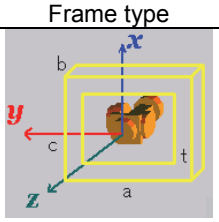
Simplified setting procedures for the tool moment of inertia (registration of shape)

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 “3.9.4“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

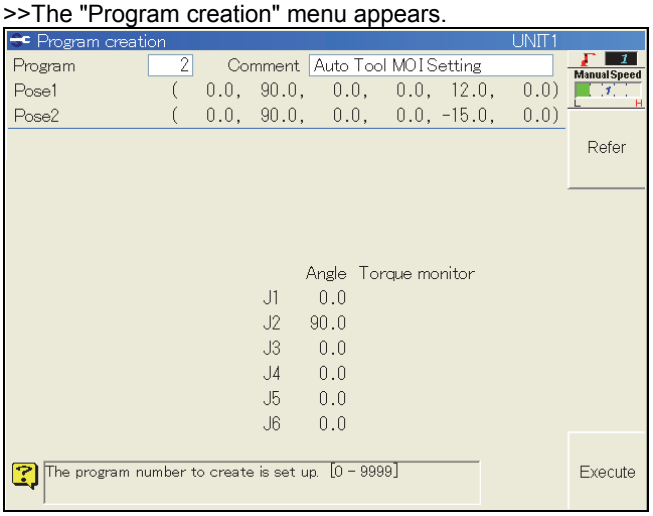
At first, create the measurement program. One measurement program can get the result of only one component of tool moment of inertia (X or Y or Z). So in order to get the all components of tool moment of inertia, three measurement programs are necessary.

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

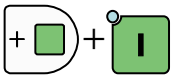
2 **Press [RESET/R], [2], [9] and [Enter].**
Dialog box to input the tool number is now opened. Input the tool number to be selected and press [Enter] key.
>>The tool number selected here is recorded in the measurement program.

3 **Set the operator qualification to *EXPERT* or above.**

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.



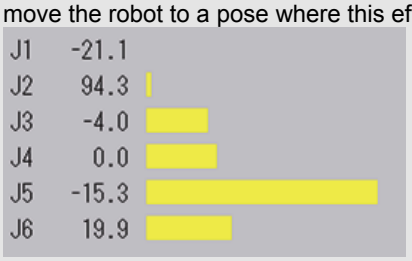
6 **Two poses are necessary for the automatic measurement program.**
Turn on the motor power and move the robot manually to the target poses while taking care that the robot and tool will not interfere with the nearby equipment.

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.

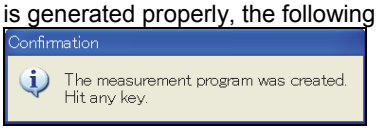


By the phrase "while the robot is in the hold status" is meant the state in which the motor power is ON but the robot is at a standstill. Take care when the robot is operated since the torque monitor pointer will deflect significantly due to the operation.

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.

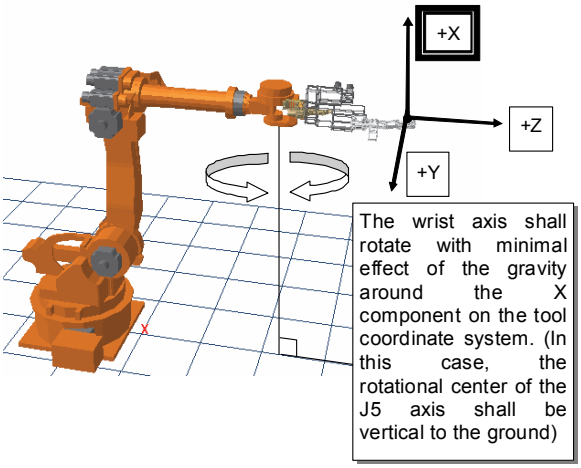
9 **Finally, press f12 <Execute> key.**
>>Based on the recorded poses, measuring program is generated. When the program is generated properly, the following confirmation dialog box appears.

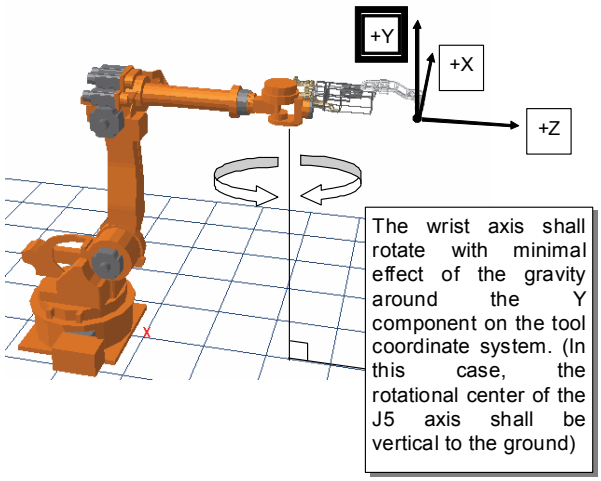


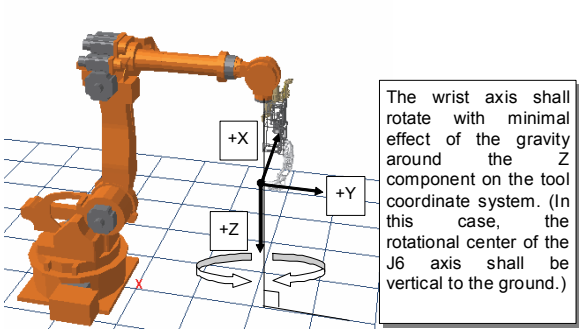
(Reference)
“X” or “Y” or “Z” is automatically added as the last character of comment. (This X/Y/Z direction is automatically determined from the recorded two postures.)

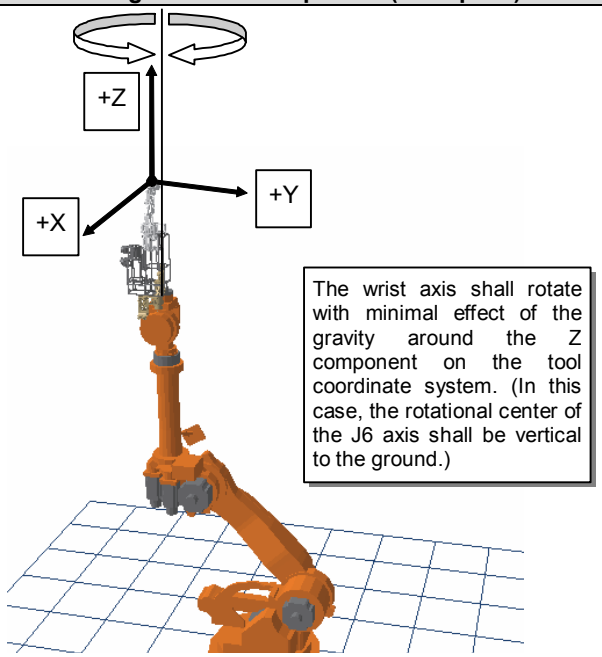
10 **Press [RESET/R] key to return to the service utilities menu.**
In same way, create three measuring programs.

See following figures as sample.

<table>
<tr><th>Program for X component</th><th>Program for Y component</th></tr>
<tr><td> 

＜Angle of each axis (J1,J2,J3,J4,J5,J6)＞
POSE1 : (0, 90, 0, -90, 0, 90)
POSE2 : (0, 90, 0, -90, -90, 90)</td><td> 

＜Angle of each axis (J1,J2,J3,J4,J5,J6)＞
POSE1 : (0, 90, 0, -90, 0, 0)
POSE2 : (0, 90, 0, -90, -90, 0)</td></tr>
<tr><th>Program for Z component (example 1)</th><th>Program for Z component (example 2)</th></tr>
<tr><td> 

＜Angle of each axis (J1,J2,J3,J4,J5,J6)＞
POSE1 : (0, 90, 0, 0, -90, -90)
POSE2 : (0, 90, 0, 0, -90, 0)</td><td> 

＜Angle of each axis (J1,J2,J3,J4,J5,J6)＞
POSE1 : (0,135, 45, 0, 0, 90)
POSE2 : (0,135, 45, 0, 0, 0)</td></tr>
</table>

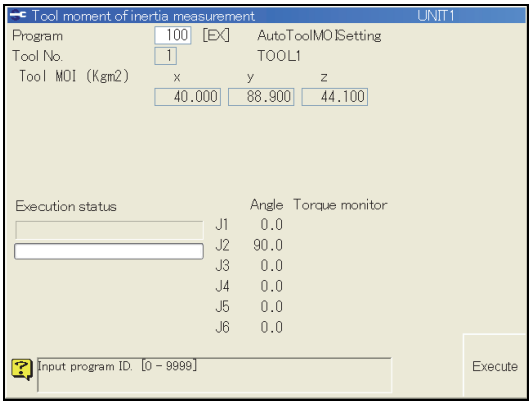
(Reference)
Taught program can be utilized to create the measuring program.
Press f8 <Refer>. Then input the taught program number and press [Enter] key. First move step is used as pose 1 and second move step is used as pose 2.

(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.

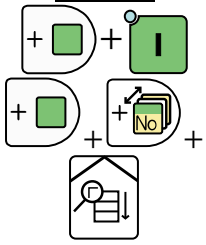
Specify the tool number of the tool whose moment of inertia is to be measured by proceeding as in step 2.
Operator qualification must be *EXPERT* or above.
For the system with multiple manipulators, press the "Mechanism" key on the teach pendant, and select the mechanism that you measure the tool moment 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 the motor power source circuit ON.**

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

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 "3.9.4"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.

3.5.6 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.

This radius has absolutely no effect on the operations and paths during manual operations and playback. It is used to check interference territory and other purposes.

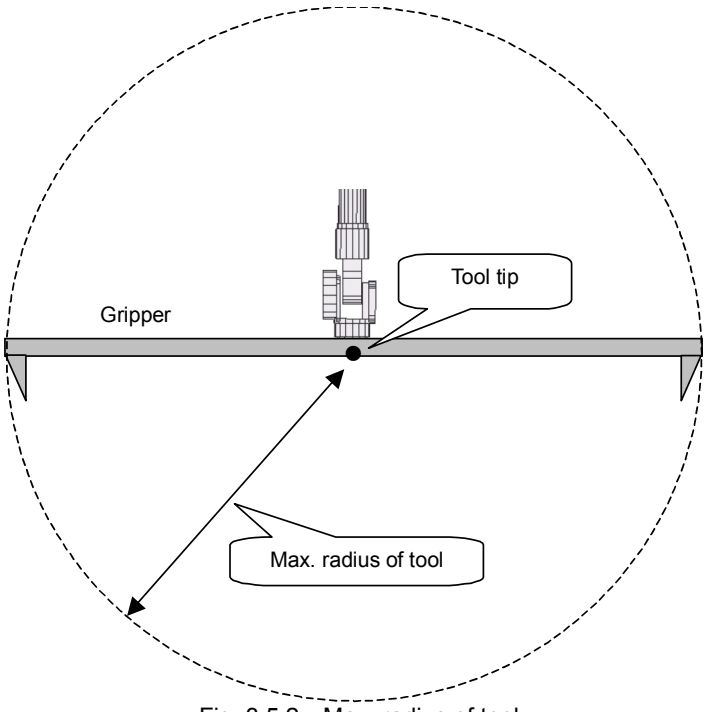
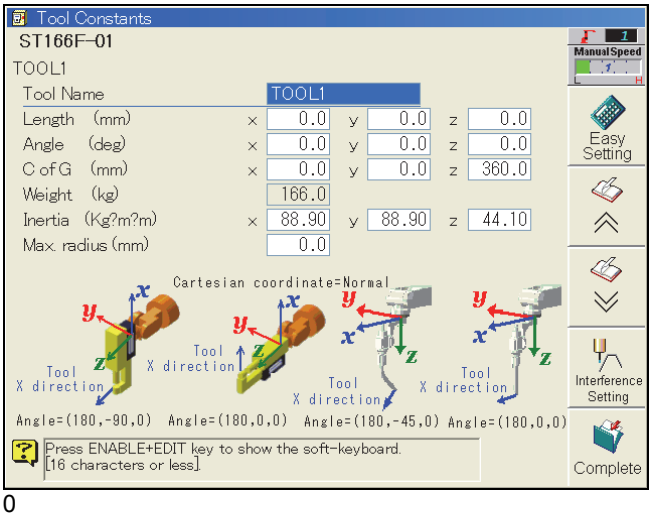


Fig. 3.5.2 Max. radius of tool

3.5.7 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.**

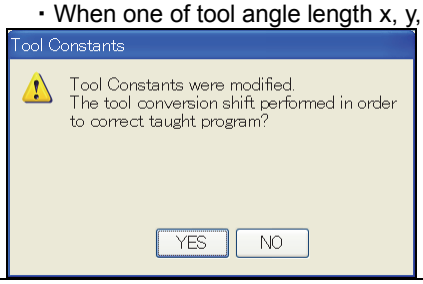


0

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

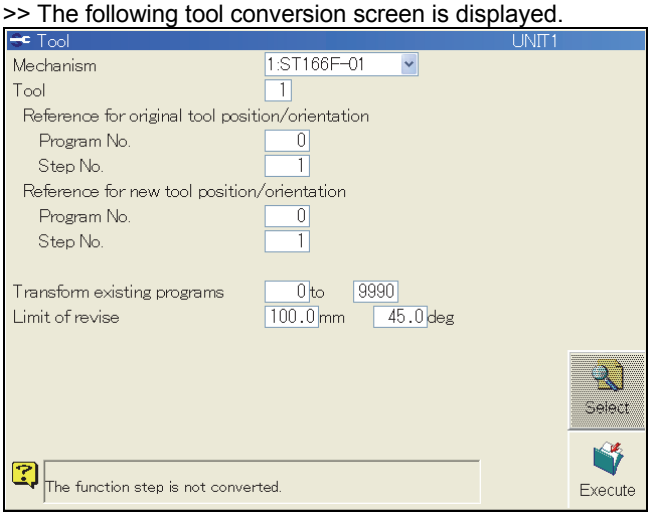
>> The change of tool constants can be checked by either of the following changes.

- 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.**

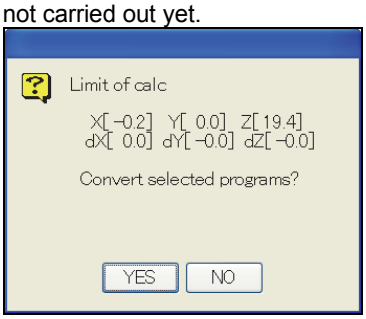
>> The following tool conversion screen is displayed.



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.

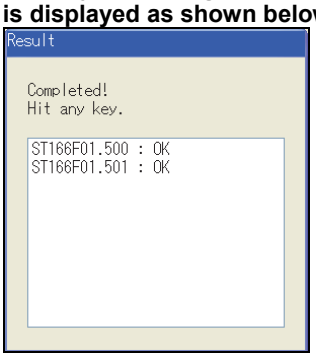
4 **Press <Execute> key.**

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.

3.6 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.

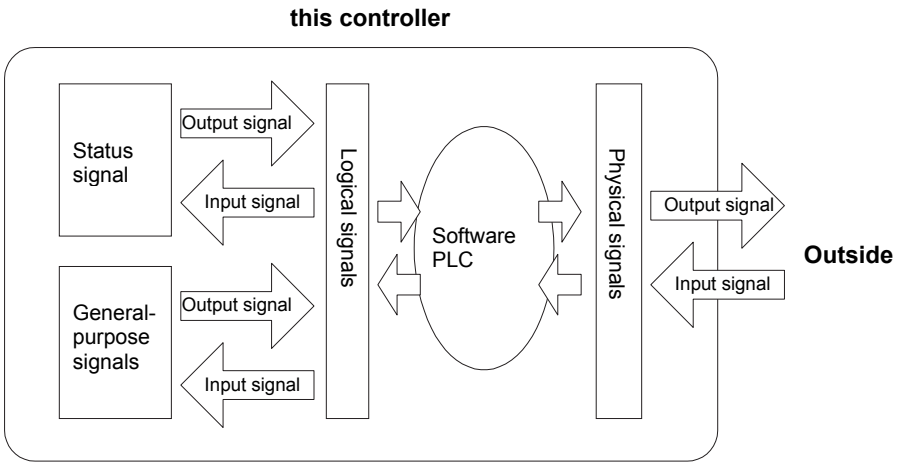
Table 3.6.1 Types of signal attributes

	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 construction	**Logical signals**	This is a blanket 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 blanket 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.



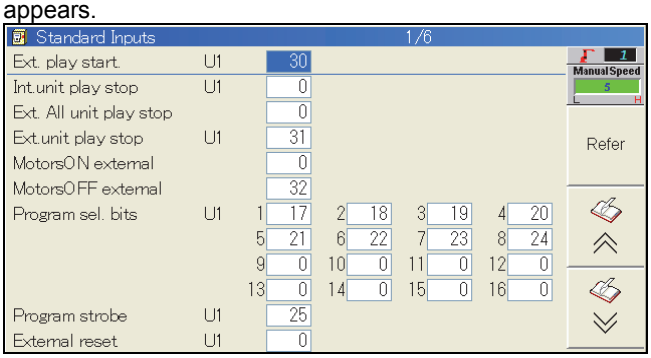
If a software PLC is not going to be used, the logical signals and physical signals are directly connected.

Fig. 3.6.1 Signal attributes

3.6.1 Standard signal attributes assignment

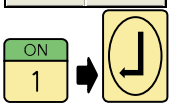
1 **Select the teach mode.**

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.



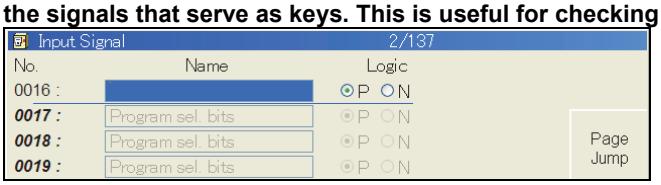
(For details on the spot welding signals and other special-purpose signals, refer to the operating instructions of the application concerned.)

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]" signifies 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.

3.6.2 Standard input signals

For details, refer to the following instruction manual.

"FD CONTROLLER INSTRUCTION MANUAL : EXTERNAL INPUT/ OUTPUT" (TFDEN-007)

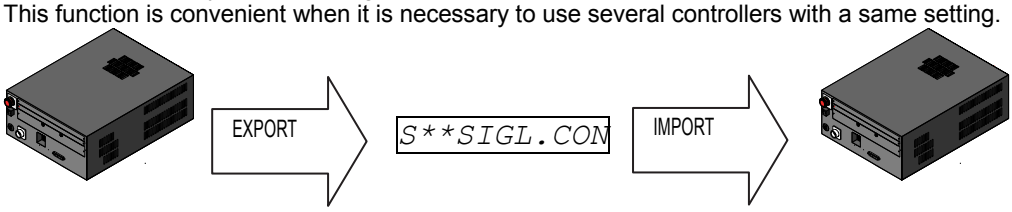
3.6.3 Standard output signals

For details, refer to the following instruction manual.

"FD CONTROLLER INSTRUCTION MANUAL : EXTERNAL INPUT/ OUTPUT" (TFDEN-007)

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

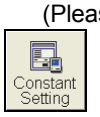
It is possible to copy the I/O settings between the controllers. (Import / export)
This function is convenient when it is necessary to use several controllers with a same setting.



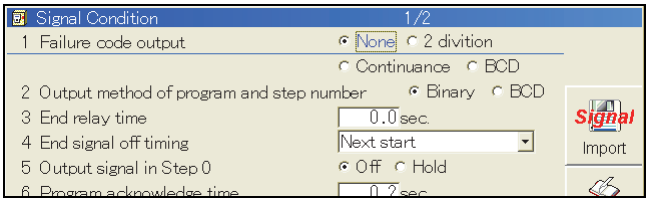
This operation should be performed after switching the operator class to ***EXPERT*** or higher.

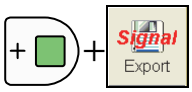
Exporting the setting file

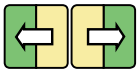
Let's export the I/O setting to the USB memory (RC Ex.Mem1).
(Please insert an USB memory to this robot controller in advance.)



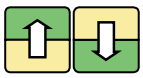
1 **Open <Constant settings> - [6 Signals] – [1 Signal Condition] menu.**



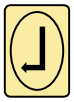




Window selection

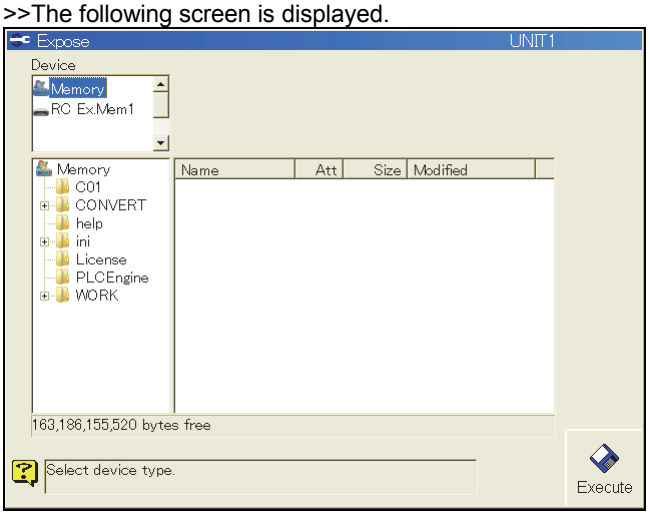


Item selection

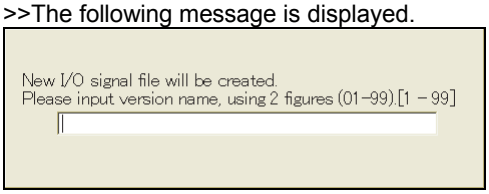


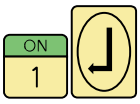
Enter

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.



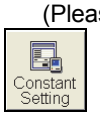


4 **Input the 2 digits (1-99) and press [Enter].**
>>A file with the following name will be created in the destination folder.
S**SIGL.CON ("**" is the inputted number)

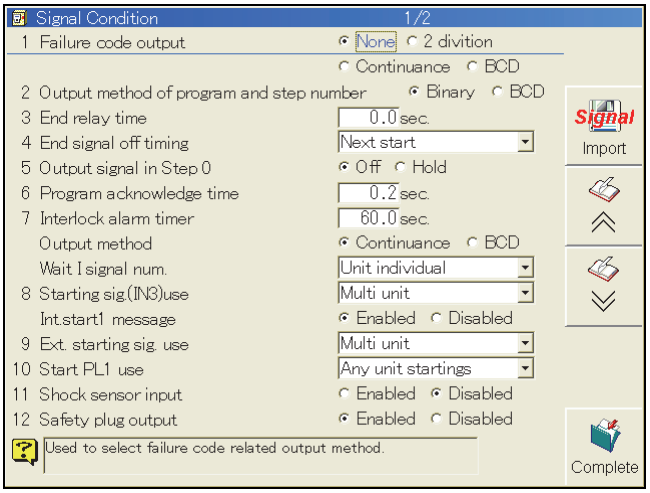
Importing the setting file

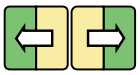
Let's import the I/O setting file that was exported to the USB memory in the previous section to the other controller.

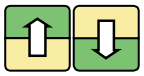
(Please insert the USB memory to the robot controller in advance.)

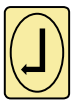


1 **Open <Constant settings> - [6 Signals] – [1 Signal Condition] menu.**

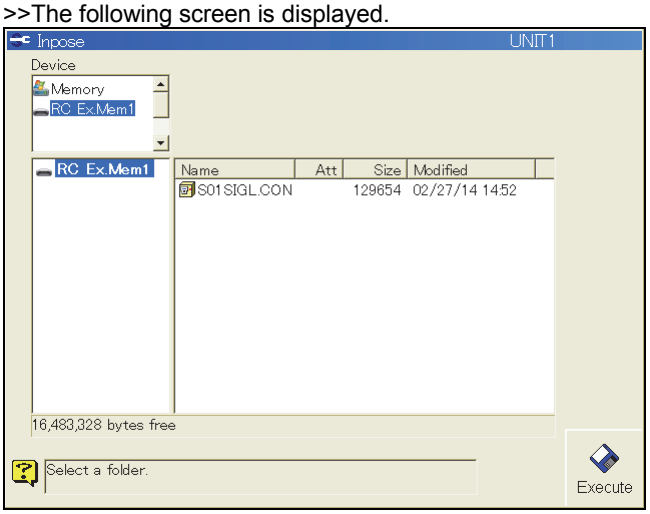



Window selection

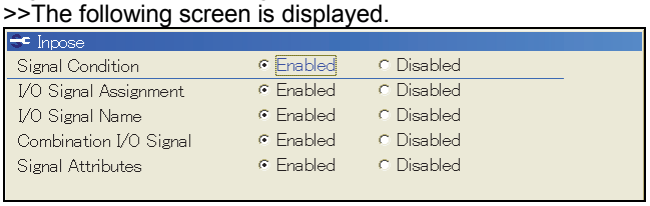

Item selection

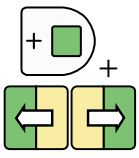

Enter

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.





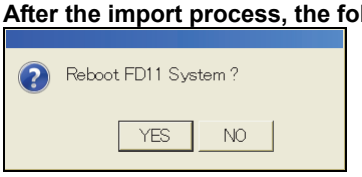
4 **Set *"Enabled"* for the field that you want to import.**

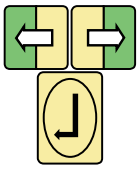
Signal condition	[SIG_COND]
I/O Signal Assignment	[IN_ASSIGN],[OUT_ASSIGN]
I/O Signal Name	[SIG_NAME]
Combination I/O Signal	[SIG_ASSIGN]
Signal Attribute	[SIG_ATTR]

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.

"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] – [2 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] And <Constant Setting> - [6 Signals] [3 Output Signal Assignment] [7 Combination Outputs]
Example	MULTIIN_NAME_5101=ABC The name of I5101 is "ABC". MULTIOUT_NAME_5101=DEF The name of O5101 is "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 “3.8 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.

3.7 Concerning the qualifications of the operators

3.7.1 Operation qualifications

The 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*** (elementary 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 3.7.1 Classes of operator qualifications

Operator qualifications	Operators targeted	Content
BEGINNER	Elementary 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 3.7.2 Main functions whose access is restricted

Operator qualifications / 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; –:not displayed in part.

3.7.2 Procedure for changing the operator qualifications

When the control power is turned on, either ***USER*** or ***BEGINNER*** is set as the operator qualifications class. If an operator has the qualifications of ***EXPERT*** or above, either class may be set. page 3-50 "3.7.4How to set the operator qualifications class at power-on"
To change the class of qualifications 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 qualifications class to ***EXPERT*** or above.
The initial passwords are listed below. The passwords can also be changed.
page 3-49 "3.7.3How to change the passwords"

Table 3.7.3 Initial password

Operator qualifications	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 qualifications class.
* Since the initial passwords for ***EXPERT*** and ***SPECIALIST*** are given in these instructions and are open to anyone who reads the instructions, elementary level or regular operators can easily change their own qualifications to the ***EXPERT*** or ***SPECIALIST*** class.
Since there is a danger that the constants and other settings required to operate the robot may be changed in error by an elementary level or regular operator, the initial passwords must be changed as soon as the robot is delivered.

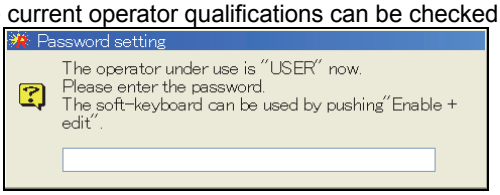
How to change the operator qualifications class

R

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

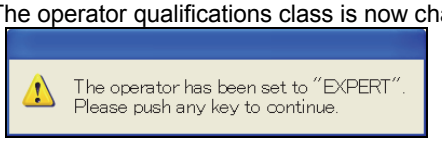
314 → ↵

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



Pass word → ↵

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 qualifications class, press [Enter].
If ***SPECIALIST*** is the qualifications class, press "12345" followed by [Enter].
>>The operator qualifications class is now changed.



Operation returns to the original screen by pressing any key.

3.7.3 How to change the passwords

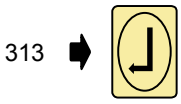
It is possible to change the passwords (for ***EXPERT*** and ***SPECIALIST***).
Alphanumerics (a distinction is made between upper case and lower case letters) and symbols are used as the characters which can be input for a password. All characters must be half-sized characters only. A password must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

CAUTION

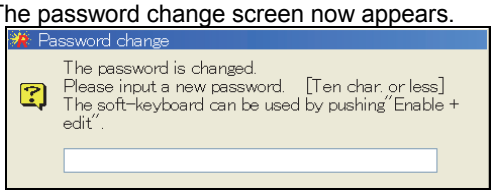
EXPERT or ***SPECIALIST*** operators must make a note of the new password which they have changed themselves without fail so that they will not forget it. If an operator has forgotten a password, the password cannot be set again insofar as he or she does not have a higher class of operator qualifications.

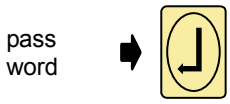
How to change the passwords

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

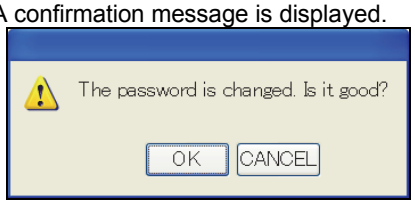


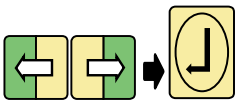
2 **Input "313" using the numeric keys, and press [Enter].**
>>The password change screen now appears.





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.

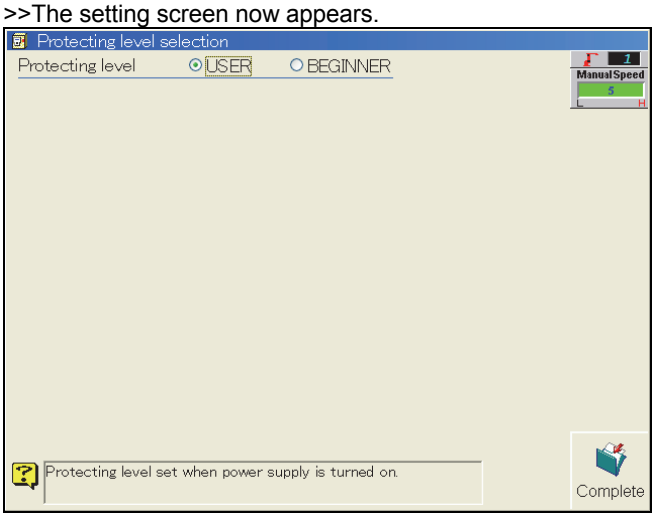
To cancel the change, select [CANCEL], and press [Enter].

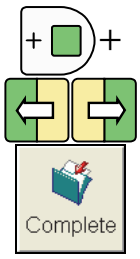
3.7.4 How to set the operator qualifications class at power-on

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

3.8 I/O area mapping function

3.8.1 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.

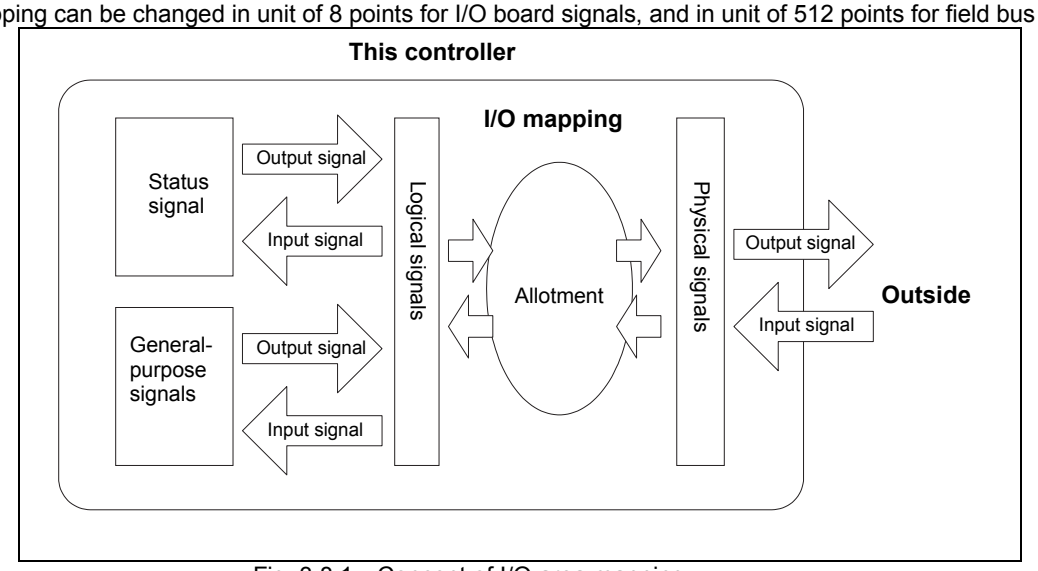


Fig. 3.8.1 Concept of I/O area mapping

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 3.8.1 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 (8 points x 1)	97 to 104
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 3.8.2 I/O area mapping setting change example

Physical port	Logic I/O signal	Description of mapping contents
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 (8 points X 1)	-	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 3.8.3 "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.

3.8.2 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.

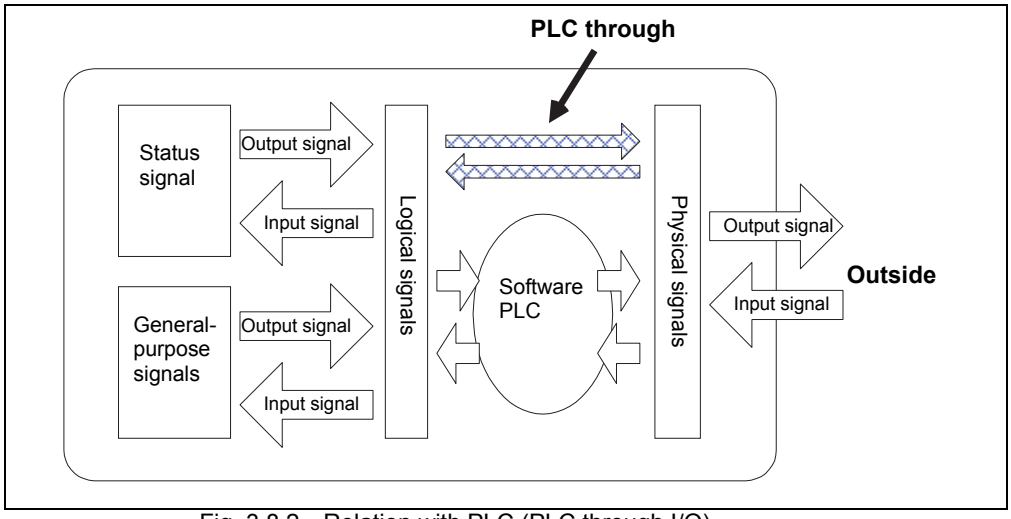


Fig. 3.8.2 Relation with PLC (PLC through I/O)

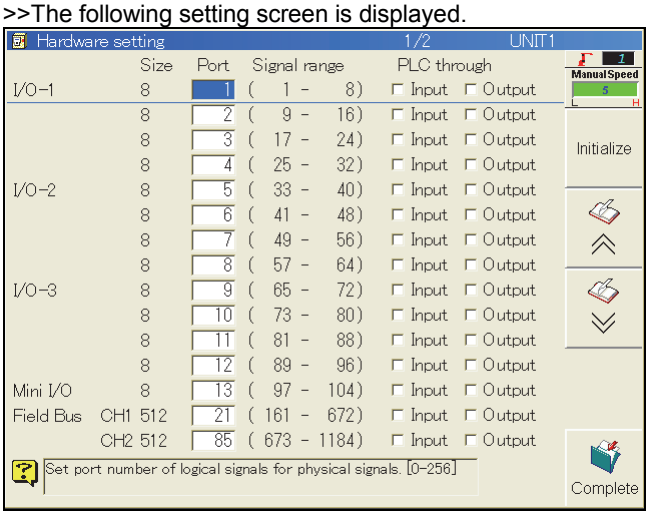
By the way, this function causes no influence upon software PLC itself, even if a rudder to be operated to signal of mapping change is written, it itself works normally. (However, actually, designated signals are input / output made directly with physical port.)

3.8.3 Setting method

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

1 **Select teach mode.**

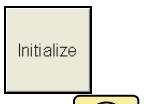
2 **Select <Constant Setting> - [6 Signals] - [15 Hardware setting].**
>>The following setting screen is displayed.



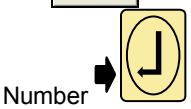
When mapping information is not written in "S00SIGL.CON" file, the above value is set as default setting.

Meanings of display items are as shown below.

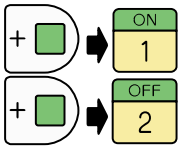
Parameter	Description
Number of points	This shows the number of signal points of each physical medium. 8 points x 4 for one I/O board. Field bus has 512 points of signals per channel.
Port	This designates the logic signal number of this controller by port number. For example, when "1" is designated by I/O board, the range of corresponding input signal is I1 ~ I8, and output signal is O1 ~ O8. When "12 is designated by field bus, the range of corresponding input signal is I1 ~ I512, and output signal is O1 ~ 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).**



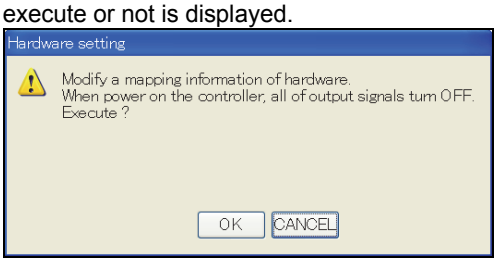
4 **Move the cursor to each logic port, and input numeric value of mapping information by port number.**
When "0" is input, no input / output with the physical medium.



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.

3.8.4 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 ~ 2048 are allotted to field bus signal.

When this is set as shown below, input / output signals of field bus are mapped to 1 ~ 2048, all the 2048 points can be used.

Table 3.8.4 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	PLC through 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	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.

3.8.5 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 3.8.5 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	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

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

When to forcibly input the input signals from I/O board 1 as I1 to I32, irrespective of PLC, and forcibly output 033 to 064 to I/O board 2, make the setting as shown below.

Table 3.8.6 Mapping example (forcibly 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	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 ~ Y95 is not output to I/O board 2. Output is the status of 33 to 064.)

POINT

Only signals checked in PLC through process are forcibly 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.

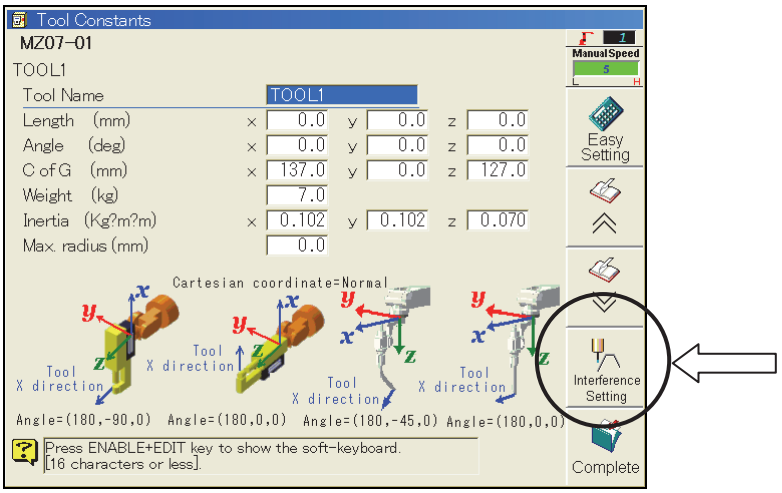
3.9 High Speed Interference Detection

3.9.1 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 equipments. By utilizing this function, when mis-operation occurs during teaching work or some error occurs during playback, unexpected interference is detected to stop the robot immediately.

3.9.2 Applied machine types

A robot in which a "***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.



3.9.3 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.

- C of G [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 "3.5 Tool constant settings".

3.9.4 “Interference setting” screen

For this procedure, the operator must be qualified as an ***EXPERT*** or above.

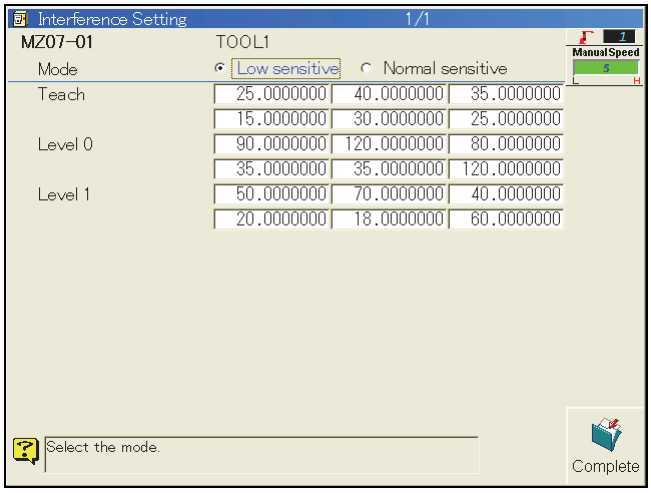


Table 3.9.1 Interference setting parameter

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. Threshold value for detection is lower than that of “Low sensitive”. (Notes) After performing the “Simplified setting of tool moment of inertia” function, this setting is automatically set to “Normal sensitive”. If the “Automatic setting of tool moment of inertia” function is used, please select the “Normal sensitive” 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 playbackmode 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.

3.9.5 Switching Detection Level by Function

It is possible to switch the threshold value regarded as interference during playback.
For example, when inserting the end effector into narrow space, interference is checked strictly by changing the threshold value lower. On the other hand, when carrying out the contact work, threshold value 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 threshold value of level 0 is used (default). 1: This switches to specification condition at high sensitivity. The threshold value of level 1 is used. 2: This is designated when to get low sensitivity. The threshold value 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 above.

Unless this function is used, the threshold value 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.

3.9.6 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 threshold value or change to disabled by recording FN230(COLSEL) only around trouble steps.
Refer to ☞ “3.9.5 Switching Detection Level by Function” for FN230(COLSEL).

3.9.7 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.

3.10 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

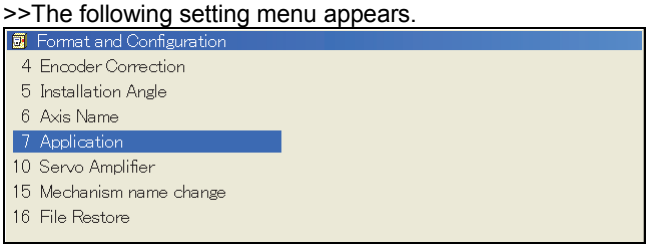
Only configure these settings once prior to the first time of use. Inadvertently changing them later may cause problems such as the initialization of various settings and the inability to use functions that were used up until that time.

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].

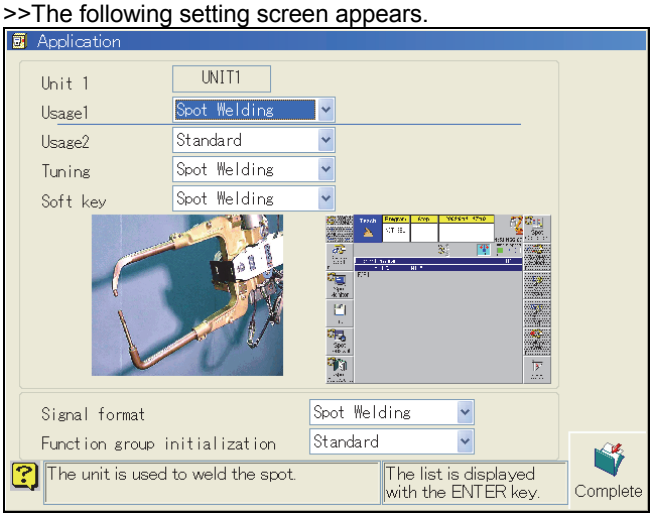
Configuration example

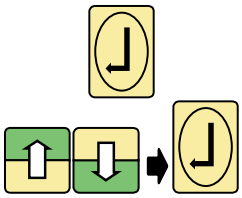
1 **First, input R314 and select operator qualification *EXPERT* or above.**

2 **Select teach mode and <Constant Setting> - [12 Format and Configuration].**
>>The following setting menu appears.

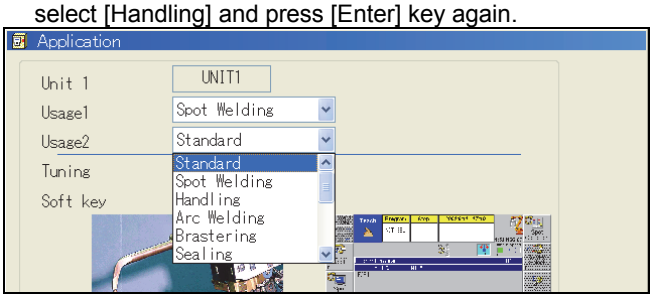


3 **Select [7 Application] from the menu.**
>>The following setting screen appears.





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.
Handling:	For using the robot for a handling application.
Arc Welding:	For arc welding with an arc welding torch. (This is necessary to use the weaving function)
Sealing:	For sealing with a sealing gun.
Palletizing:	For palletize function

Table 3.10.1 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	Select “Standard” always.
Soft Key	Set the optimum soft key (f key) layout for the application type.

Table 3.10.2 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).

3.11 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.

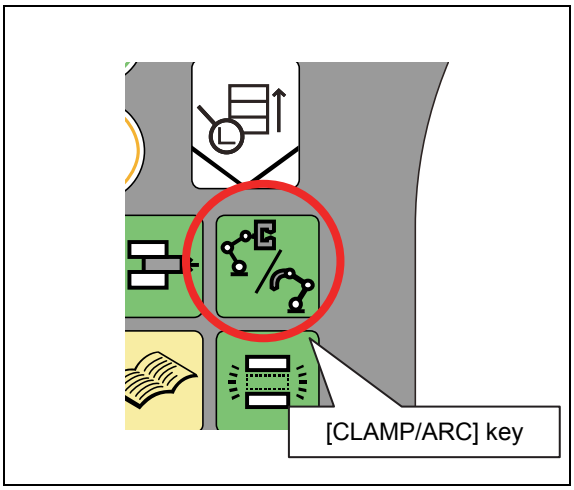


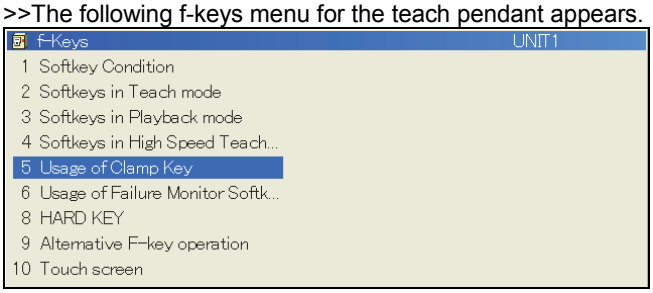
Fig. 3.11.1 [CLAMP/ARC] key of the teach pendant

The function of (1) and its usage are described hereinafter.
(Currently, (2), (3) and (4) are not available in the CFD controller.)

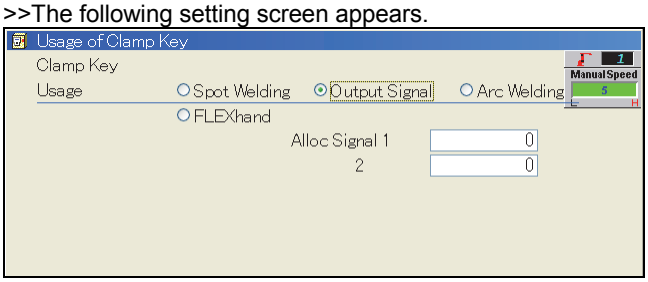
Setting Procedure

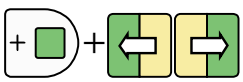
1 **First, input R314 and select operator qualification *EXPERT* or above.**

2 **Select teach mode and <Constant Setting> - [7 f-Keys].**
>>The following f-keys menu for the teach pendant appears.

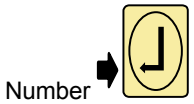


3 **Select [5 Usage of Clamp Key] from the menu.**
>>The following setting screen appears.





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.

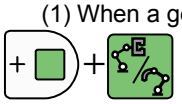
6 After completion of the settings, press the f12 <Complete> key.
The settings are written to the controller general constant file C00ctrl.con.
To stop configuring the settings, press the [RESET/R] key.

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)

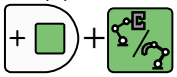
(1) When a general-purpose output signal is set



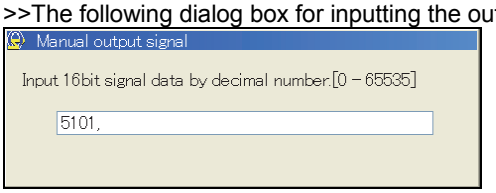
1 In teach mode, the set output signal can be turned ON/OFF manually.
Using the signal assigned to signal 1 of the clamp key output as the reference signal, output is performed by switching between ON and OFF alternatively.
The ON/OFF state of the output signal assigned to signal 2 is always the opposite to that of signal 1.

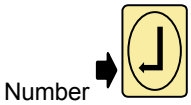
>>Pressing the [ENABLE] and [CLAMP/ARC] keys when signal 1 is OFF.
→Signal 1 is set to ON and signal 2 is set to OFF, regardless of the state of signal 2.
>>Pressing the [ENABLE] and [CLAMP/ARC] keys when signal 1 is ON.
→Signal 1 is set to OFF and signal 2 is set to ON, regardless of the state of signal 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.

3.12 Setting the software limit (operating range)

3.12.1 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 3.12.1 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.
* Limit area: The area the robot cannot move out of even if there is a failure or malfunction with the robot system.

WARNING

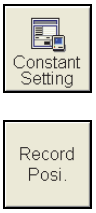
When software limit is changed, please do not forget to confirm that robot surely stops at the defined software limit by manual operation. If this procedure is omitted, wrong setting by mistaking operation may result in loss of life, serious injury, or an accident.

CAUTION

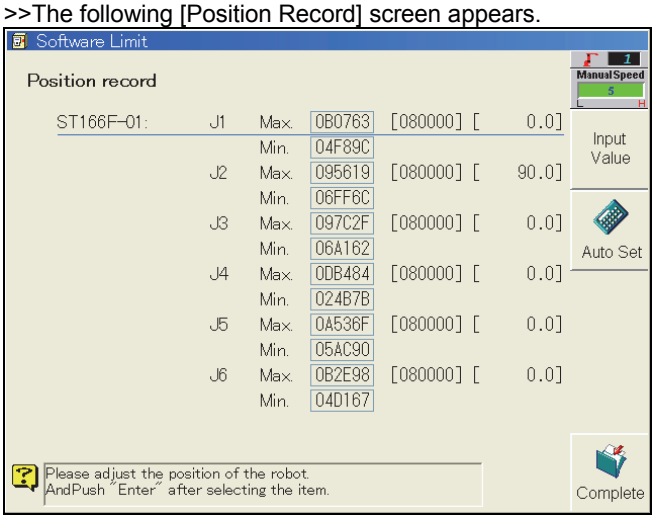
The following items are **not supported** for auto setting of the software limit.
(1) Servo gun axis*(The checkmark cannot be turned ON)
(2) Endless axis*(The checkmark cannot be turned ON)
(3) Other than angle commands of robotic language for each axis angle (MOVE/ MOVEJ/MOVEX_J/MOVEX_E)
* Calculation is not performed automatically, but values can be input directly in the data input area.

3.12.2 [Position record] screen settings

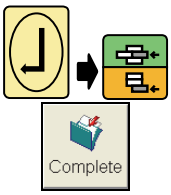
Operate the robot to move each of its axes manually and set the software limit values.
The operator needs to have the ***EXPERT*** qualification set to perform this operation.



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.

CAUTION

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.

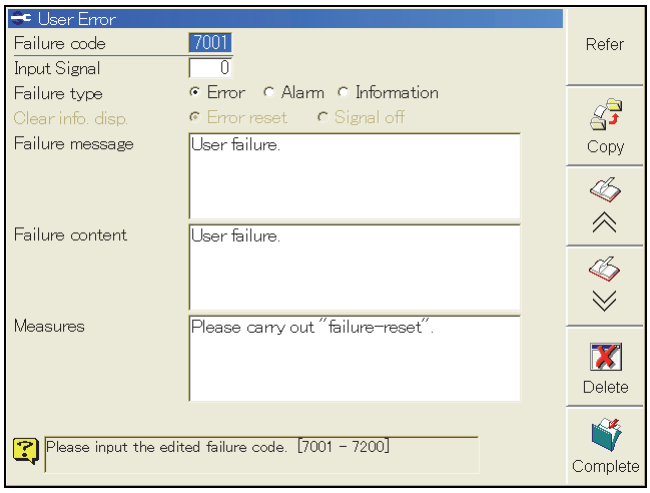
3.13 User defined error

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.

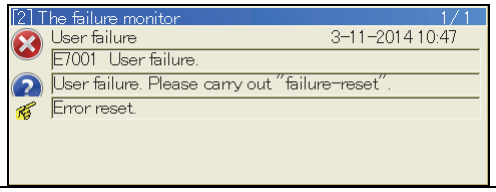
Copy the content of the current user error to the other error number.

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.**



<table>
<tr><th>Item</th><th colspan="2">Description</th></tr>
<tr><td>Failure code</td><td colspan="2">This is the error number. (7001 to 7200)
 
If the system software version is less than FDV03.21, the setting range is from 7001 to 7099.</td></tr>
<tr><td>Input Signal</td><td colspan="2">This is the trigger signal (input signal) to display the error. (0 to 2048)</td></tr>
<tr><td>Failure Type</td><td colspan="2">Select the type of the error (Error / Alarm / Information)
For details, refer to the following manual.
“CONTROL AND MAINTENANCE FUNCTION” Chapter 4</td></tr>
<tr><td rowspan="3">Clear info. disp.</td><td colspan="2">In case of “Information”, “Error reset” or “Signal off” can be selected.
This setting can be changed only in case of “Information”.
 
This setting item is available only in the system software FDV03.21 or after.</td></tr>
<tr><td>Error reset</td><td>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.</td></tr>
<tr><td>Signal off</td><td>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.</td></tr>
<tr><td>  Failure message</td><td colspan="2">Input the error message
Character input screen is displayed by [Enable] + [Edit].</td></tr>
<tr><td>  Failure content</td><td colspan="2">Input the error content.
Character input screen is displayed by [Enable] + [Edit].</td></tr>
<tr><td>  Measures</td><td colspan="2">Input the measures.
Character input screen is displayed by [Enable] + [Edit].</td></tr>
</table>

3.14 User coordinate system

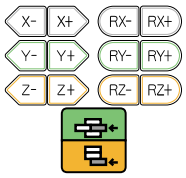
If a ***"User coordinate system"*** is defined in advance, the teaching operation may become easier in some cases. (E.g. in a case in which the work-table installation direction is not parallel with the machine (robot) coordinate system)

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.

3.14.1 Setting example

How to define a user coordinate system using a teaching program



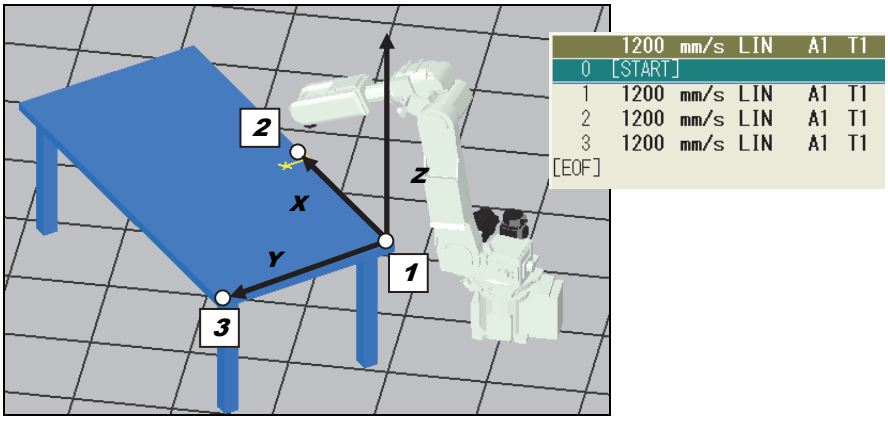
1 **First, please create a program that has 3 MOVE commands to define a user coordinate system. In this example, 3 steps are recorded in the Program No.1.**

1 : The origin(reference point) of the user coordinate system

2 : A point that determine the X axis direction

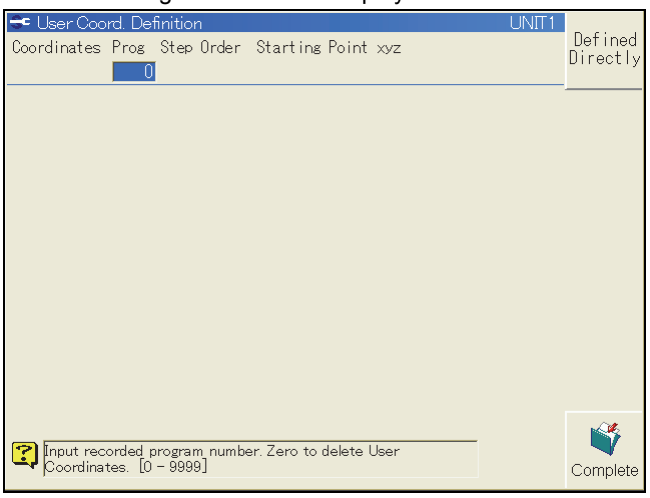
3 : A point that determine the Y axis direction

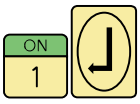
(The direction of the Z axis is automatically calculated.)



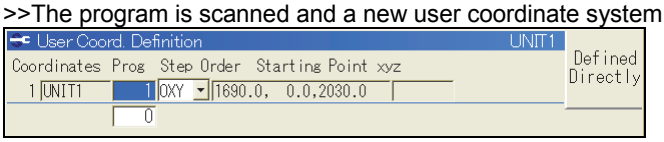
2 **Open <Service Utilities> - [10 User Coord. Definition].**

>>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.



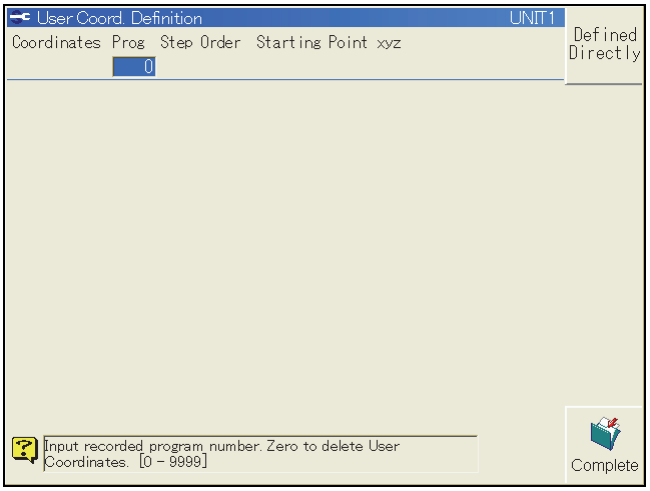
“Step Order”
OXY : Origin, a point to determine the X direction, a point to determine the Y direction
OZX : Origin, a point to determine the Z direction, a point to determine the X direction
OYZ : Origin, a point to determine the Y direction, a point to determine the Z direction

4 **Press <Complete>**
>>The defined user coordinate system 1 is saved in the internal memory.

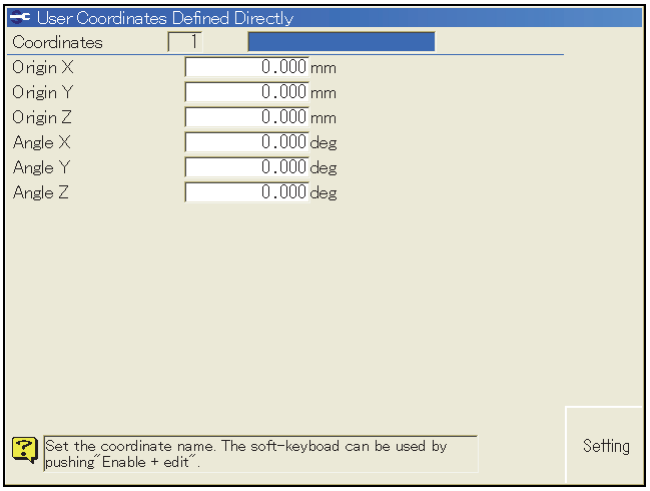
5 **Press [R] key several times to exit from the setting menu.**

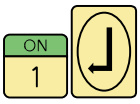
How to define a user coordinate system by direct input (FDV04.05or after)

1 **Open <Service Utilities> [10 User Coord. Definition>**
>>The following screen will be displayed.

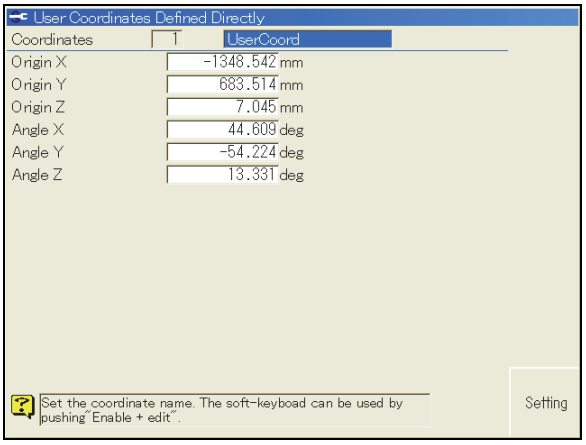


2 **Press <Defined Directly”**
>>The following screen will be displayed.



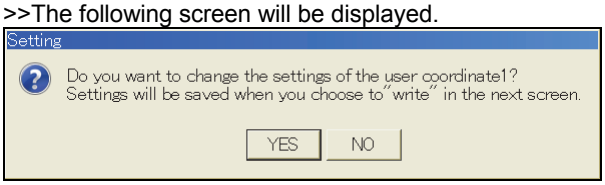


3 **Input the origin and the direction.**



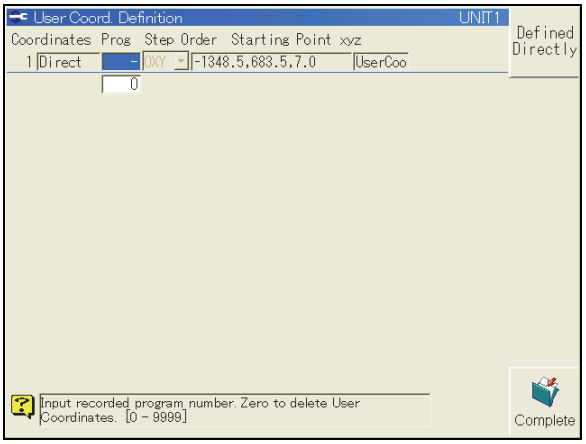
4 **Press <Setting> key.**

>>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.)

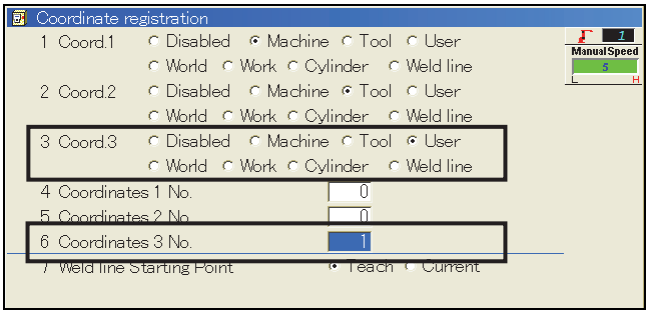
6 **Press <Complete>**

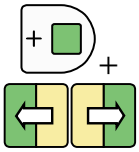
>>The defined user coordinate system 1 is saved in the internal memory.

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.
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.

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.

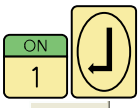


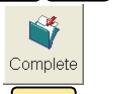


2 **Change the setting like the followings;**

"3 Coord.3" = "User"

"6 Coordinates 3 No." = "1" (The No. of the defined user coordinate system)

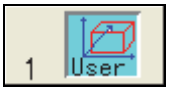


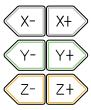


3 **Press <Complete>**
>>The setting is saved in the internal memory.

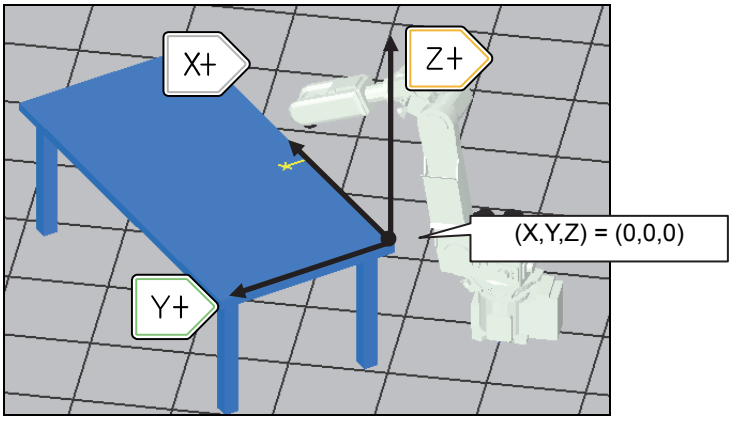
4 **Press [R] key several times to exit from the menu screen.**

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.



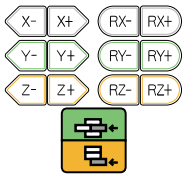
3.14.2 Stationary tool

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.

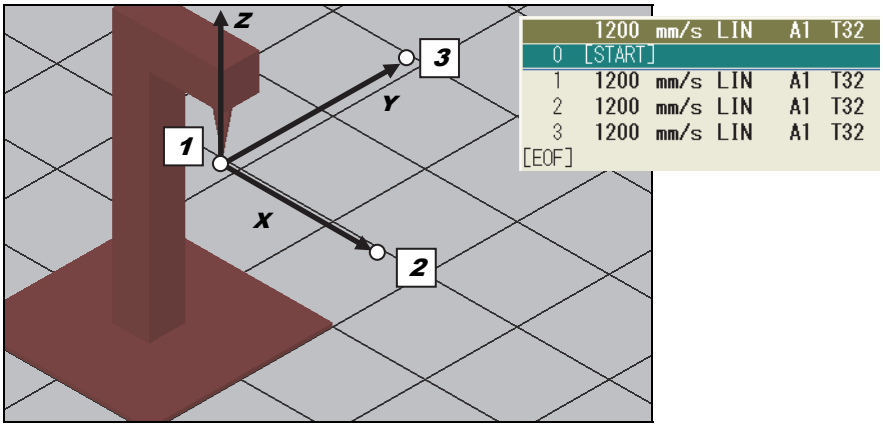
POINT

- 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.)

How to define a user coordinate system for a stationary tool

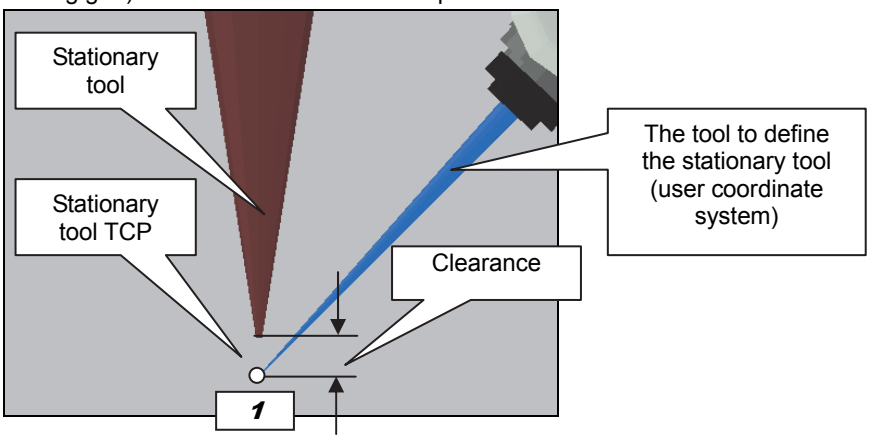


1 **Move the robot tool tip to the position of the stationary tool tip, and record the position as the origin (reference point 1). And then record other 2 points referring to the following picture.**



(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 "3.14.1Setting example")**

>>Via the operations in the following pages, this user coordinate system can be used as a ***"Stationary tool coordinate system"***.

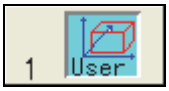
How to operate the robot based on the stationary tool interpolation

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"***.

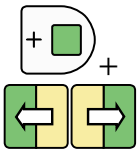
1 **Select the user coordinate system (=Stationary tool) for the manual operation.**

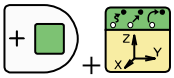


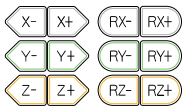
2 **Open <Teach / Play Condition> screen and set the "Interpolation origin" to "Stationary".**

>>The interpolation type in the recording status bar will change to ***"S-LIN"***

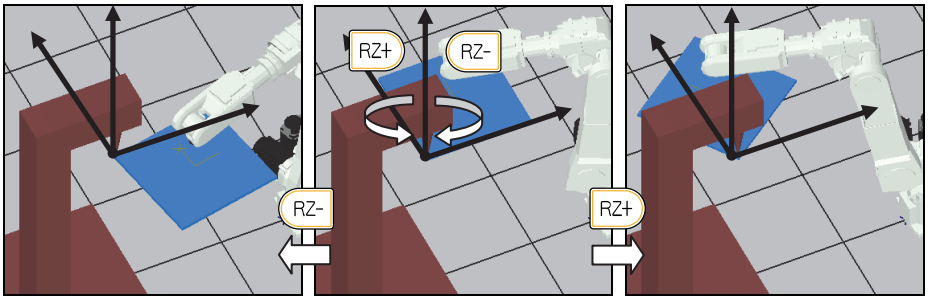
If *"S-LIN"* is not displayed, please press [Enable] + [INTERP/COORD].







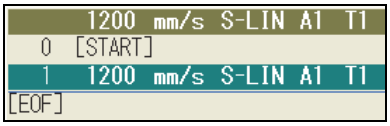
3 **When moving the robot with manual operation, the robot moves based on the stationary tool. For example, the robot will rotate around the Z axis of the stationary tool when pressing the [RZ-][RZ+] keys.**



(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.**



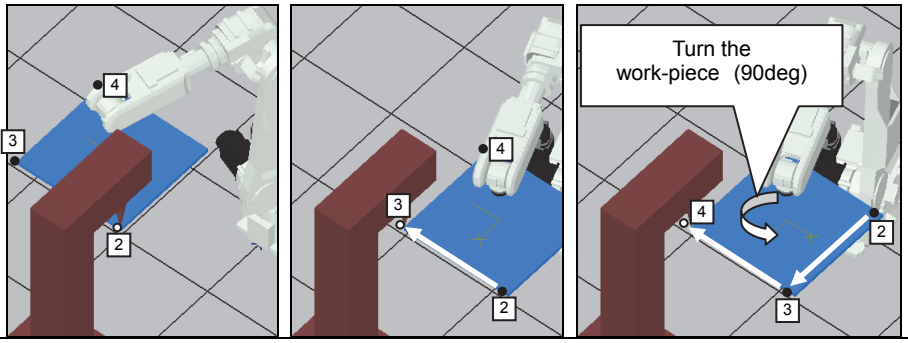
But, to execute a stationary tool interpolation while playing back a program, it is necessary to select the user coordinate system that is used as a stationary tool in advance. For this, please use ***"FN67 STOOL"***. (See the next page)

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.**

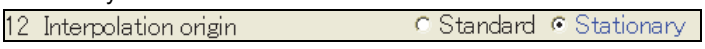
2 **Step 2, 3, and 4 should be recorded like the following pictures.**



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".

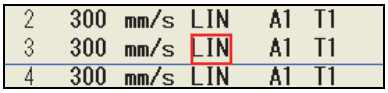


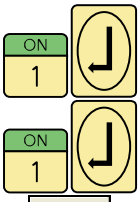
(2) The interpolation type in the recording status bar will change to ***"S-LIN"***

(3) When pressing the [REC] key, a step of interpolation type ***"S-LIN"*** will be recorded.

Method 2

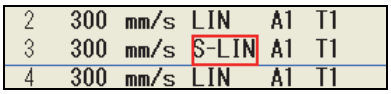
(1) After recording a MOVE command, open the edit screen and place the cursor to the position of interpolation type of the step.





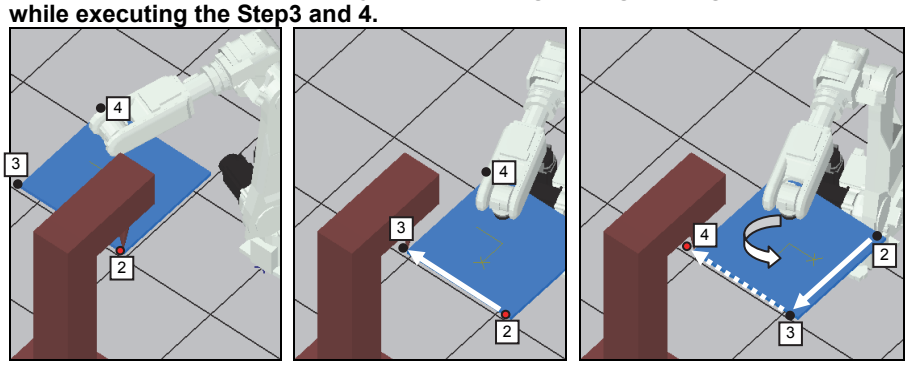
(2) Press [1], [Enter], [1], [Enter] sequently.

(3) ***"S-LIN"*** is set like this picture.



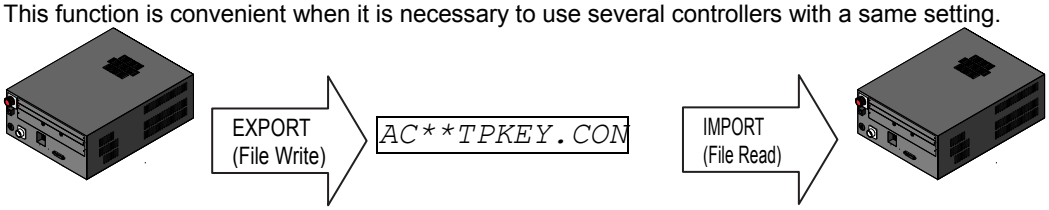
(4) After setting "S-LIN" for the desired steps, press <Complete> to save.

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.**



3.15 How to copy the soft-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.



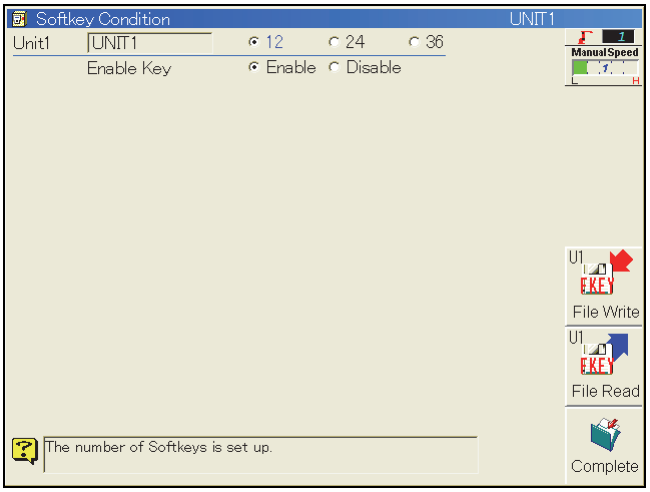
This operation should be performed after switching the operator class to ***EXPERT*** or higher.

3.15.1 Exporting the setting file

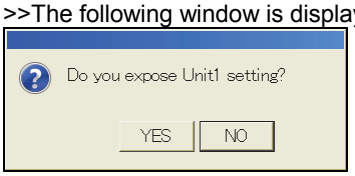
Let's export the soft-key setting to the USB memory (RC Ex.Mem1).
(Please insert an USB memory to this robot controller in advance.)

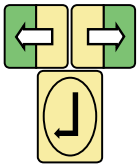
Operating procedure

1 **Open <Constant Setting> - [7 f-Keys] [1 Softkey Condition].**

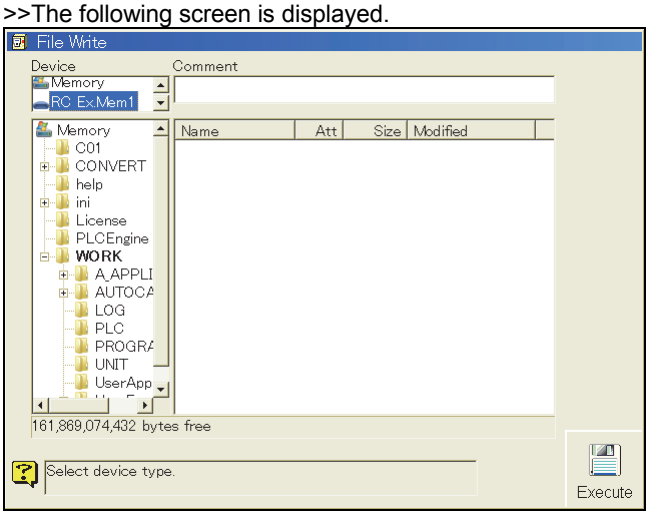


2 **Press <File Write>**
>>The following window is displayed.

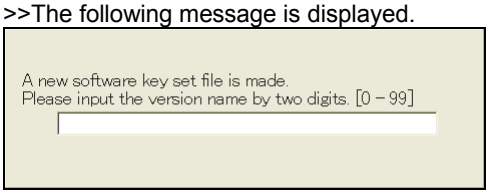


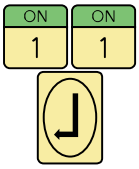


3 **Select “YES” and then press [Enter].**
>>The following screen is displayed.

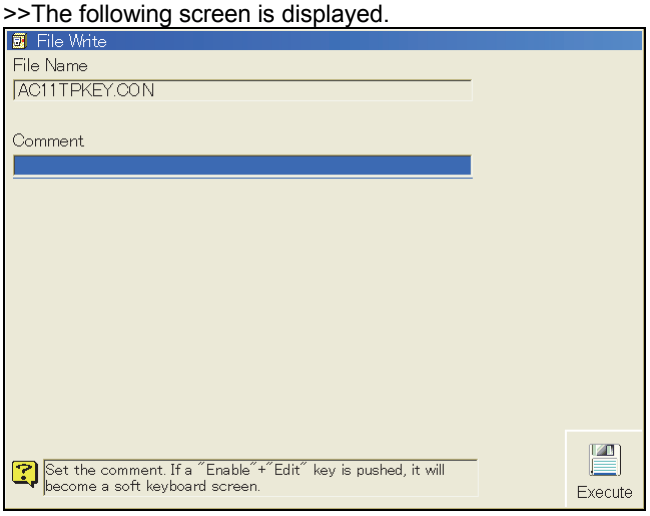


4 **After selecting the destination folder for the export (In this case, “RC Ex.Mem1”), press <Execute>.**
>>The following message is displayed.

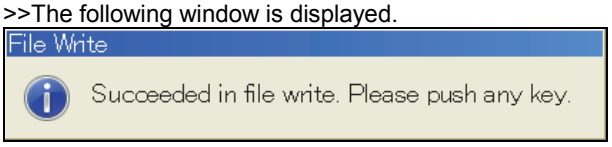




5 **Input the 2 digits (1-99) and press [Enter]. In this example, input “11” and press [Enter].**
>>The following screen is displayed.



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

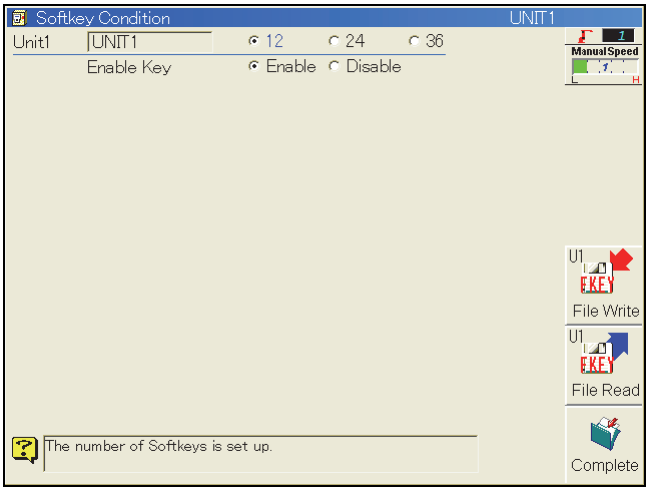
7 **Connect the USB memory to the other FD controller.**

3.15.2 Importing the setting file

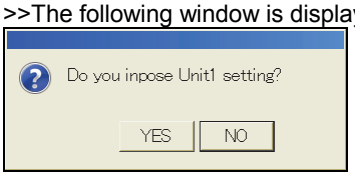
Let's import the setting file that was exported to the USB memory in the previous section.
(Please insert the USB memory to the robot controller in advance.)

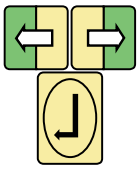
Operating procedure

1 **Open <Constant Setting> - [7 f-Keys] [1 Softkey Condition].**

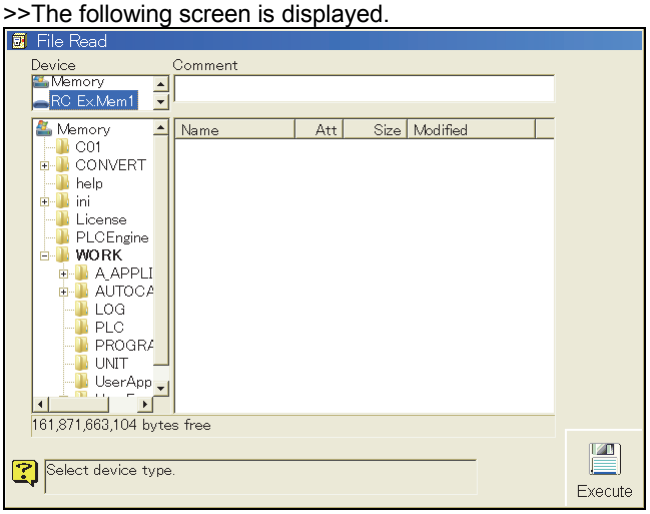


2 **Press <File Read>**
>>The following window is displayed.

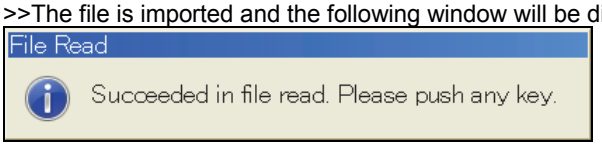




3 **Select "YES" and press [Enter].**
>>The following screen is displayed.



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.



5 **Press <Complete>.**
>>The settings will be enabled.

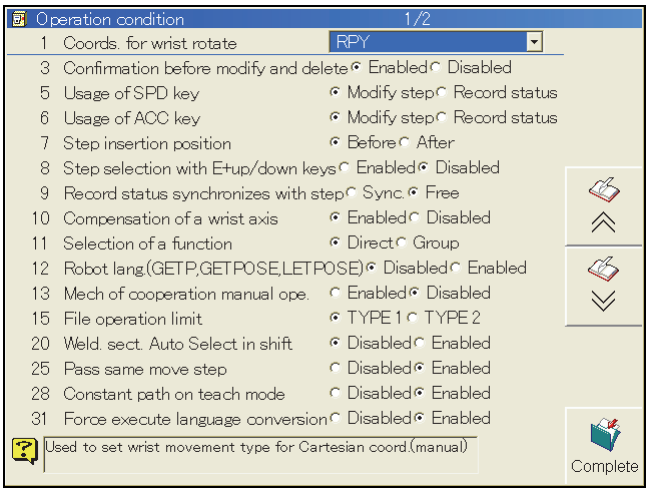
3.16 Operation condition

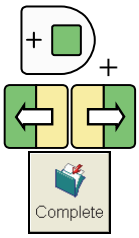
3.16.1 Operation condition

Normally, it is not necessary to change the settings in this screen.

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 3.16.1 Operation condition

Item	Description
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. (NOTE) To change this setting, an operator class of ***EXPERT*** or higher is required.

For other items, refer to the help function.

3.17 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%.

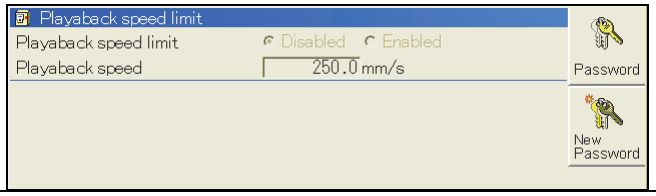
When shipping the robot, this function is “Disabled”.

3.17.1 Setting

Select the operator class ***EXPERT*** or higher in advance.

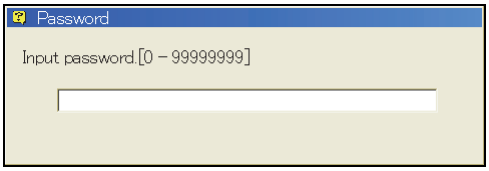
Setting procedure

1 **Open <Constant Setting> - [3 Machine Constants] [36 Playback speed limit].**



2 **The setting is protected by a password.**

>>Touch the “Password” ICON.

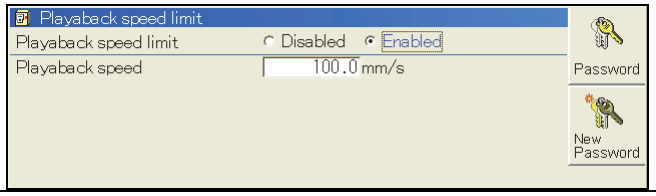


Enter the password.

- 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 3.17.1 Playback speed limit

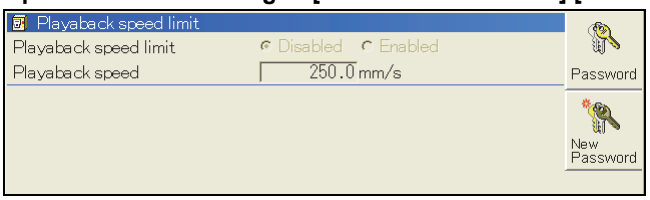
Item name	Description
Playback speed limit	Enable / Disable this function.
Playback speed	Set the maximum speed of the TCP (Tool Center Point) [0.0 to 250.0 mm/s] (NOTE) “0.0” means “Disable”.

3.17.2 How to change the password

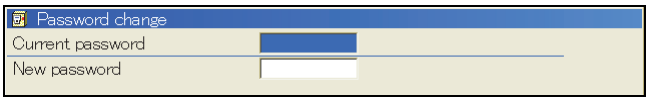
The password can be changed.

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 3.17.2 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.

3.17.3 Playback mode

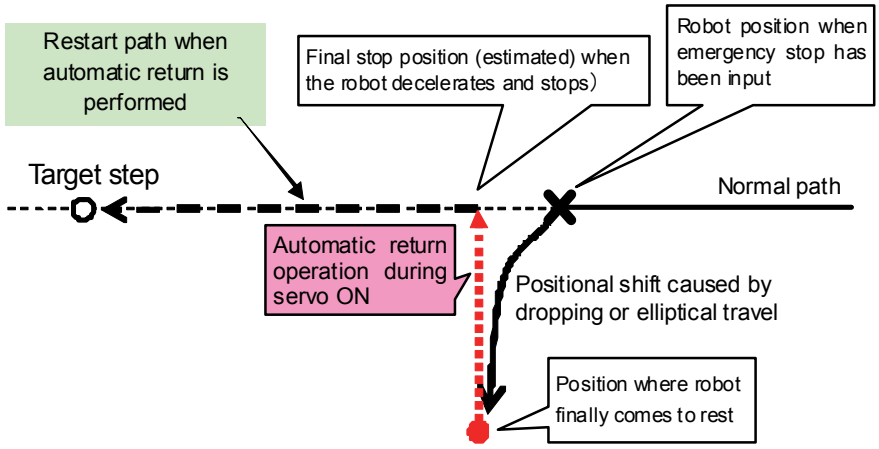
If the ***“Playback speed limit” function”*** is enabled, an ICON like the following picture will be displayed while playing back a program.

3.17.4 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)

3.18 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.



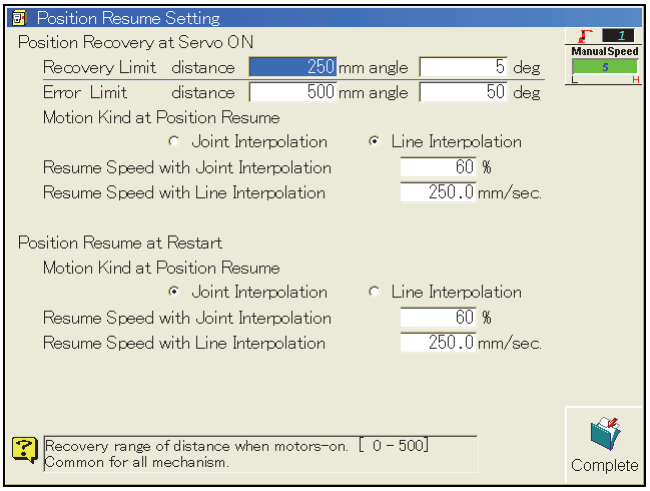
3.18.1 Setting

Select the operator class ***EXPERT*** or higher in advance.

Setting procedure

Constant Setting

1 **Open <Constant Setting> - [3 Machine Constants] [10 Position Resume Setting].**



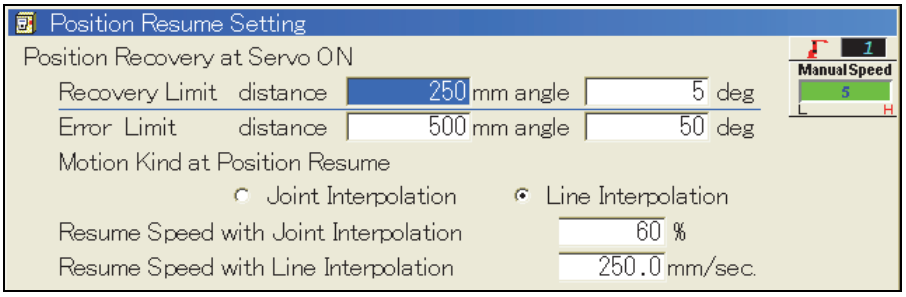
2 **Set the respective parameters.**

Complete

3 **Press <Complete> to save the setting to the internal memory.**

3.18.2 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."

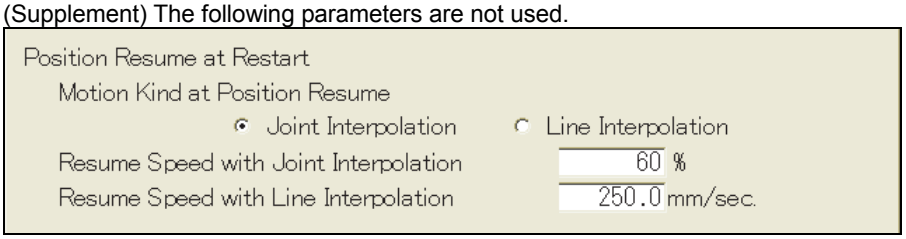


The differences in the position and posture between the time when the motor power is turned off and the time when it is turned back on are defined by the differences in the distance of the tool tip position and angle (robot wrist posture), and whether to perform the return operation or not is set depending on the extent of these differences.

Table 3.18.1 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.



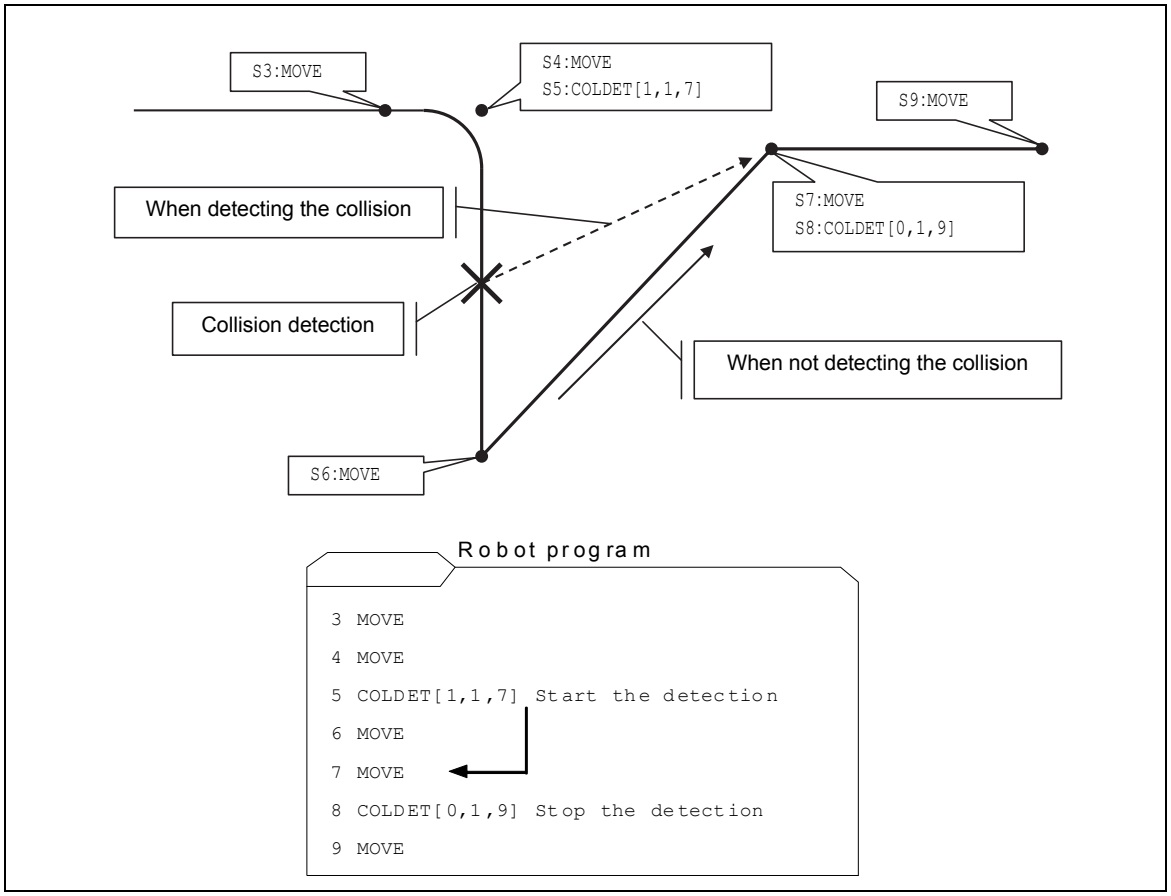
3.19 Collision detection command

3.19.1 Outline

Normally, the application commands (FN) will be executed after reaching the recorded position of the step data. Therefore, it is impossible to operate the robot like “change the motion path” or “turn ON an output signal” until it reaches the target step.

This function makes it possible to make the robot jump to the designated step (=change the motion path) or stop with error message by detecting the collision to the peripheral equipments or the work-pieces by checking the motor current.

3.19.2 Example of the operation



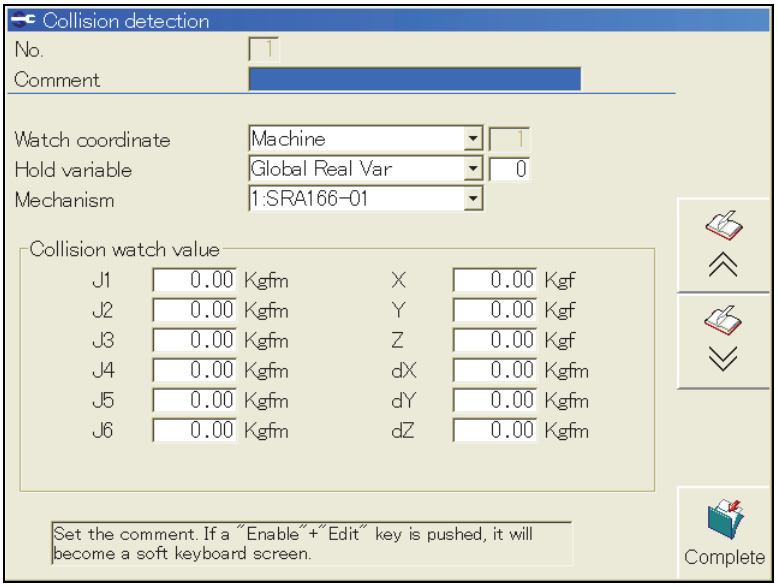
In this example, the FN31 COLDET is recorded after the step 4.

- The detection area (where the collision detection function is enabled) is the steps that are sandwiched by “`COLDET[1, ]`” and the “`COLDET[0, ]`”.
- In this area, if the robot detects the designated collision condition, it goes to the shelter step (S7). (The path shown in the dotted line in the picture)
- If the designated collision condition is not detected, the robot will follow the normal flow of the work program.

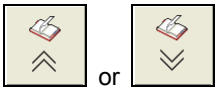
3.19.3 Settings for the conditions for the Collision detection

To use this function, the following setting is necessary.
Select the operator class ***EXPERT*** or higher in advance.
(Please use the Shortcut R314)

1 Open <Service Utilities> - [39 Collision detection.]



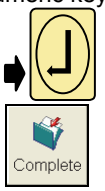
"Collision watch value" can be set only for a manipulator (robot).



2 Select the condition No. to be set.

Numeric keys

3 Set the respective parameters.
(NOTE)
When "0.00" is set, the concerned axis or the moment of the coordinate system is disabled.



4 Press <Complete> to save the setting to the internal memory.

Parameters

Item	Description
Comment	Comment of this condition
Watch coordinate	Select the coordinate system for detecting the collision. ("Machine (robot)", "Tool", or "User") (NOTE) The user coordinate system must be defined in advance.
Number	In case of "Tool", set the tool number. In case of "User", set the user coordinate system number.
Hold variable	Select the type of the variable that holds the maximum collision power. (From the "Global real variables" or the "Local real variables")
Number	Set the number of the real variable to be used. When 0 is set, the maximum collision power is not held in the variable.
Mechanism	Select the target mechanism to detect the collision. Only manipulators (robots) can be selected for this item.
Collision watch value	Set the collision torque for each axis or moment of inertia. When 0.00 is set, the axis or the coordinate system (moment) is disabled. (NOTE) For this parameter, please refer to the collision torque monitor and check the maximum values in case of normal motion.

3.19.4 Application command “FN31 COLDET”

To use this function, sandwich the area in which the collision detection is used with this function “FN31 COLDET”.

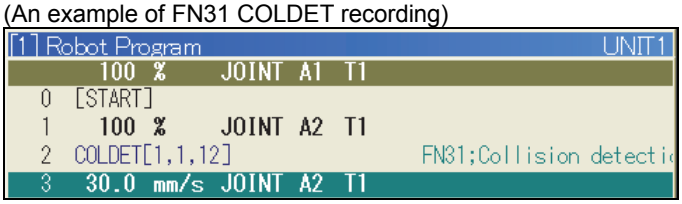
Application command : FN31 COLDET

SLIM	Number	Name
COLDET	FN31	Collision detection

Parameters

No.	Data	Content, Setting range
1	ON(1) OFF (0)	Start or stop the collision detection function. 1: ON (=Start) 0: OFF (= Stop)
2	Condition No.	Designate the condition number. (1 – 8) For details, refer to “3.19.3 Settings for the conditions for the Collision detection”
3	Shelter step	Designate the shelter step number. (1 – 10000) If “10000” is set, the robot will stop after detecting the collision with an error message.

(An example of FN31 COLDET recording)



3.19.5 Status ICON

While the collision detection function is being executed, the following ICON will be displayed on the screen.

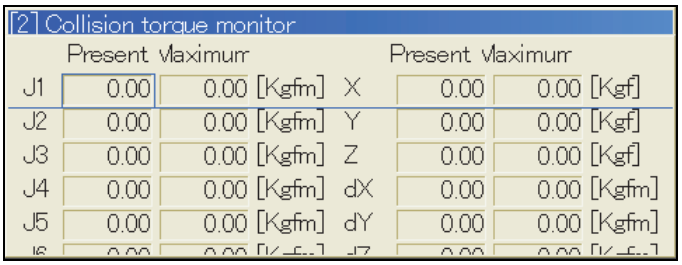
POINT

When “Program selection operation” or “Step 0 selection operation” is done while this collision detection function is being executed, this function will be disabled.

3.19.6 Collision torque monitor

To use this monitor window, select the operator class ***EXPERT*** or higher in advance.
(Please use the Shortcut R314)

1 Open <Monitor2> - [74 Collision torque monitor].



The collision torque parameters calculated for every servo control interpolation cycle are displayed.

- For the “Maximum”, the value is measured in the collision detection area sandwiched by COLDET functions (ON/OFF) and when the function is ended, the maximum value is left in this monitor window.

- When entering to a new collision detection area or when turning OFF the servo control, the maximum value will be cleared.

3.19.7 Trouble shooting

Collision detection interruption

When designating [10000] as the shelter step number for the FN31 COLDET function, it is possible to stop the robot in case of fault.

When the collision is detected in the detection area that is sandwiched by the “FN31 COLDET functions)”, the following message is displayed and the robot will stop the playback motion.

Code	A2362
Message	Detected the collision interrupt.
Content	Since the collision detected the interrupt, the robot was stopped.
Counter measure	Please confirm whether the robot manipulator interferes in something.

The limit of the number of the collision detection function

The FN31 function can be executed up to 4 at the same time.
When trying to exceed this limit number by executing the FN31 COLDET, the following message is displayed and the robot will stop the playback motion.

Code	A2363
Message	More than 5 Collision interrupt not allowed.
Content	When collision interrupt of 5 or more is executed at the same time, this error is detected.
Counter measure	Terminate the unnecessary Collision interrupt.

3.20 User help function

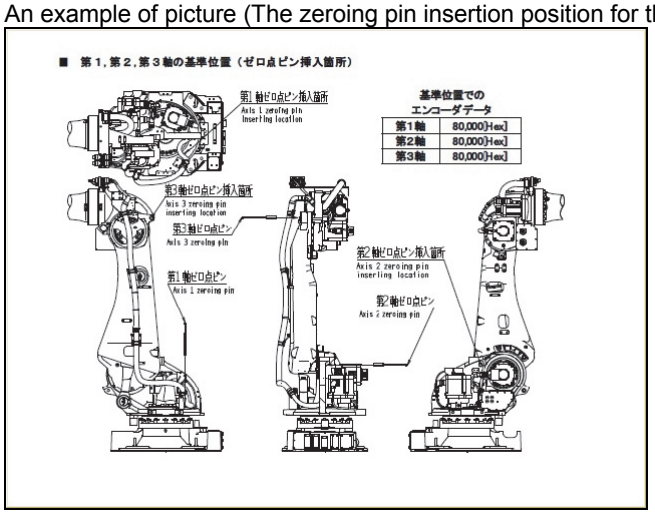
3.20.1 Outline

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.

3.20.2 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)

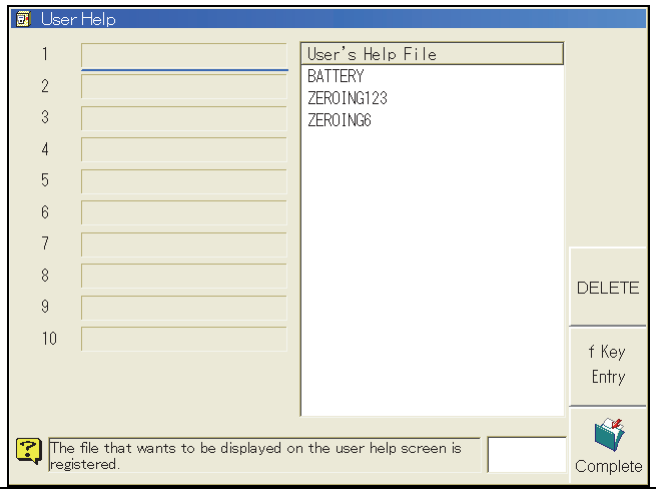
3.20.3 How to register the image file

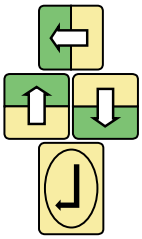
For this setting operation, ***SPECIALIST*** is necessary as the operator level.
Change the operator level using the Shortcut command R314 in advance.
(The initial parameter is “12345”)

To register an image for this function, please follow this setting procedures.

Operating procedure

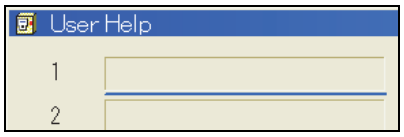
1 **Open <Constant Setting> - [38 User Help].**



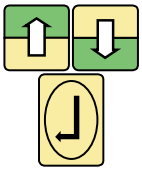


2 **Press Left cursor key to select the Registration window.**

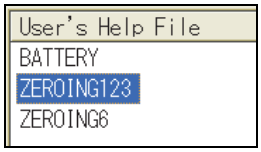
Using up/down cursor keys to select the registration number and then press [Enter].



(In this example, 1 is selected)

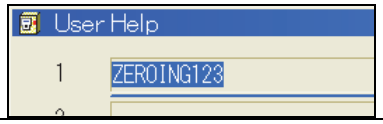


3 **The cursor will move to the right side of the screen. Select the desired image file using cursor key and press [Enter].**



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.

3.20.4 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.

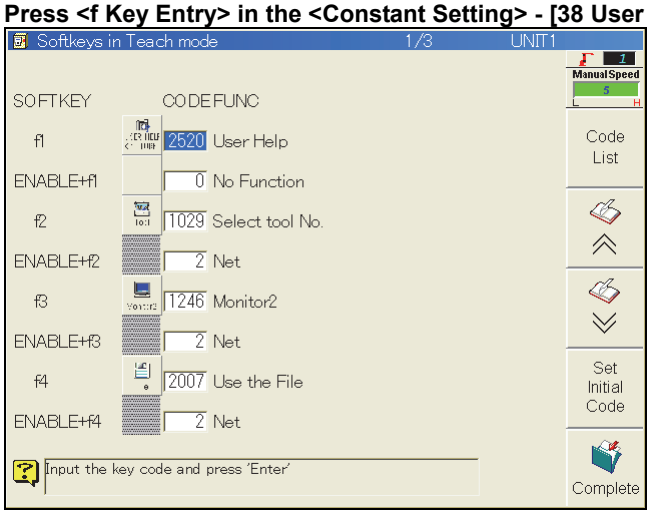
"USER HELP" software-key (CODE is 2520)

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.



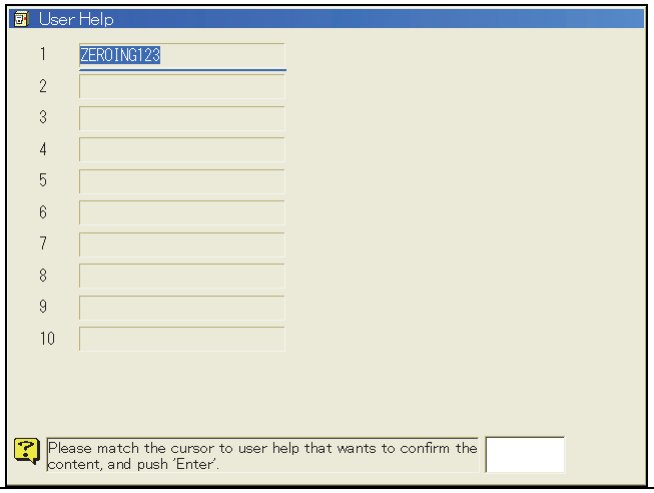
Complete

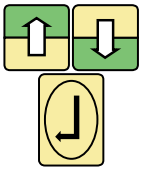
2 Input "2520" for the f1 key and press [Enter]. Then press <Complete>.
>>The setting is saved in the internal memory.

3 The "USER HELP" software-key is displayed as the f1-key in the Teach mode screen.

4 **Press the software-key [USER HELP].**

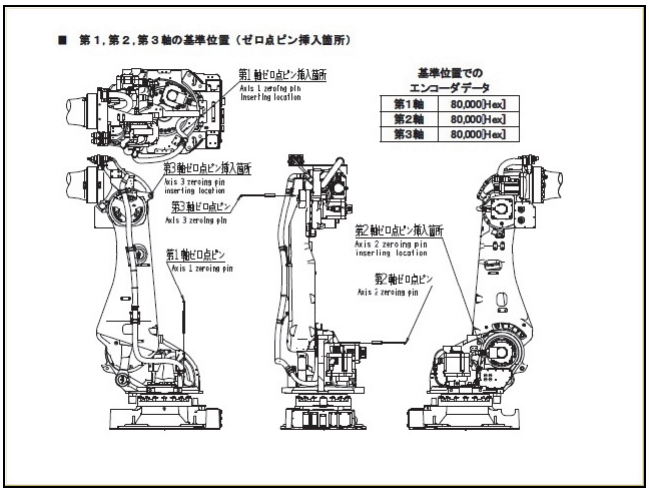
>>The following screen is displayed.





5 **Select the "ZEROING123" and press [Enter].**

>>The registered picture is displayed.



6 **Press [R] key to close the screen.**

3.20.5 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”.

3.20.6 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)

Chapter 4 Preparations for automatic operation

This chapter describes the usual preparatory steps taken to operate the robot automatically.

4.1 Home position registration

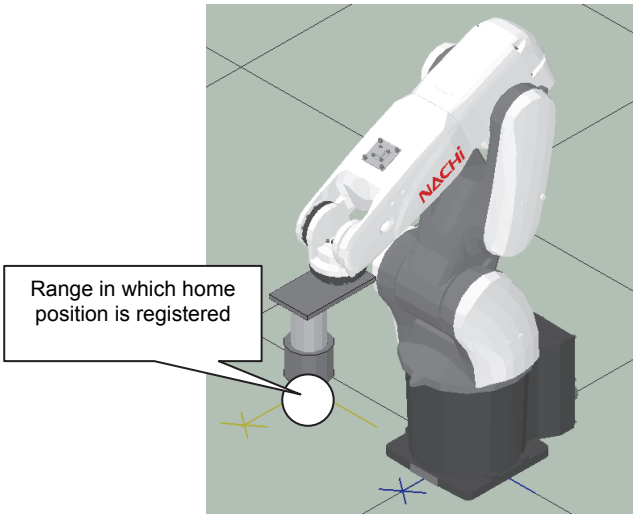
4.1.1 Home position

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.

Home position example



While the robot is in this range, the home position output signal is set to ON; when it is outside this range, it is automatically set to OFF.

Fig. 4.1.1 Home position

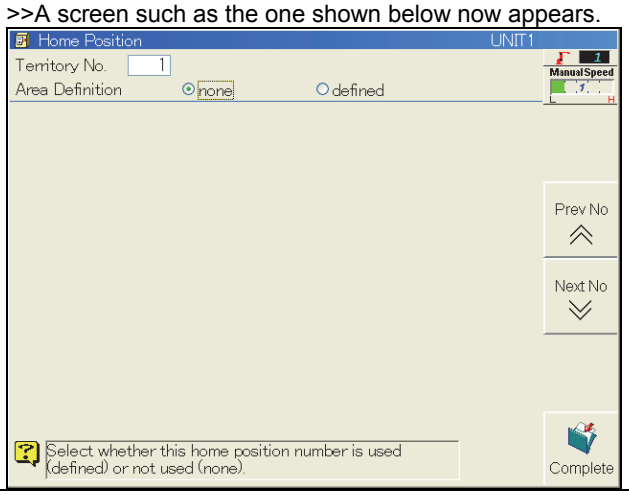
Up to 32 home positions can be registered per unit (the unit in which the task program is configured).
Some methods are provided for registering. First, the usual registration method is described.

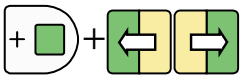
4.1.2 Home position registration by referencing the program

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.

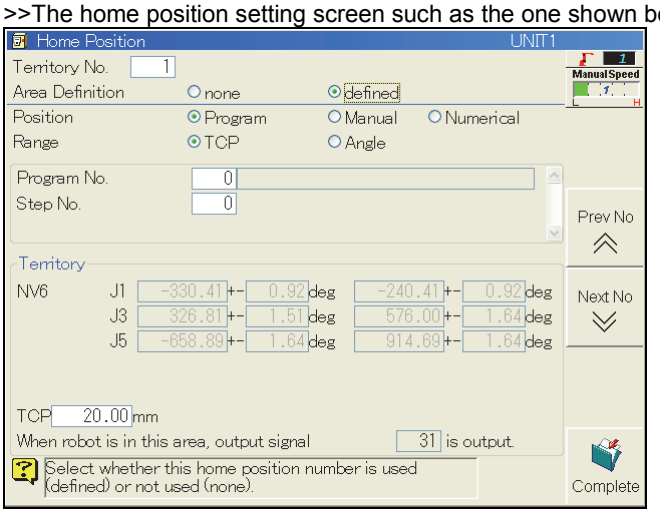
2 **Select the teach mode.**

3 **Select <Constant Setting> - [9 Territory Definition] - [1 Home Position].**
>>A screen such as the one shown below now appears.

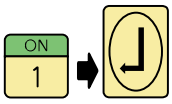




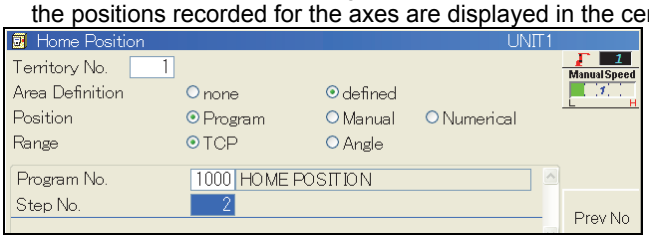
4 **Align the cursor with "Area Definition," and press[ENABLE] and left or right cursor keys together to set the radio button to "Defined."**
>>The home position setting screen such as the one shown below now appears.



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 step which were input is now called, and the positions recorded for the axes are displayed in the center.

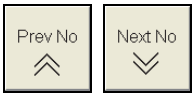


7 **Align the cursor with "TCP," input the home position range here, and press [Enter] key. The diameter of a spherical shape that can be visualized is input here. The home position signal is output when the tool tip is inside this spherical shape.**
Normally, about 20 mm is recommended.
>>The size of 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 interim 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 in tandem with this deletion.)

Registering a multiple number of work home positions

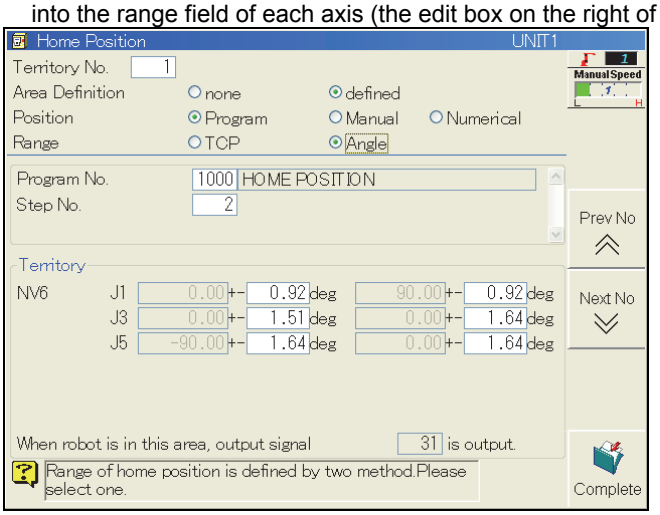


9 **A multiple number of home positions can be recorded. (Up to 32 positions per unit) To switch the screen, press [Prev No] or [Next No] key.**
Alternatively, align the cursor with the "Territory No." in the edit box, input the home position number directly, and press [Enter] key.

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.

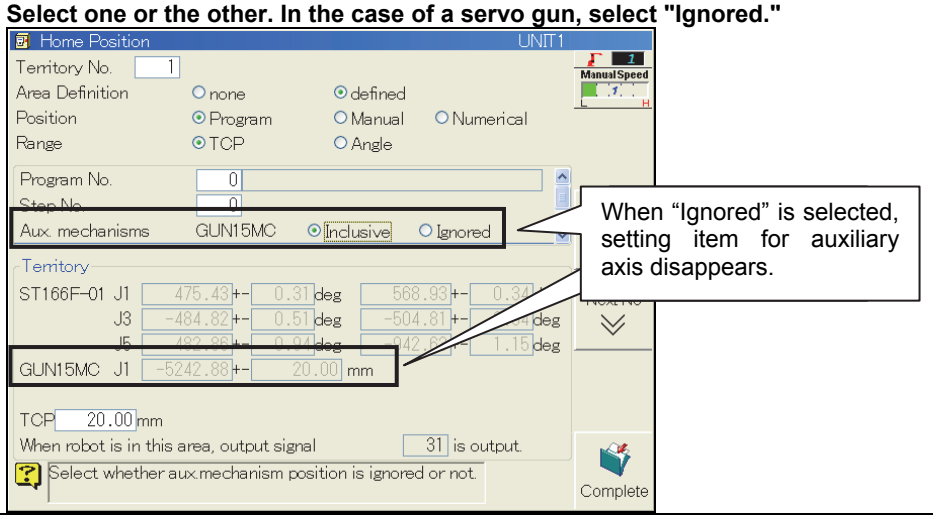
Specifying the range on an axis by axis basis

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."



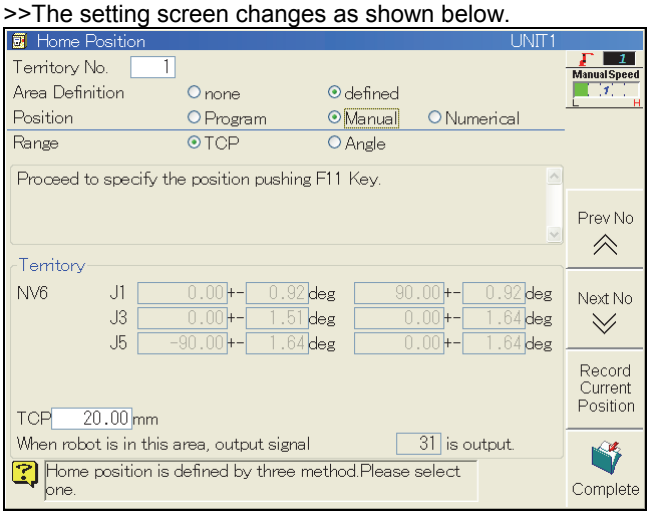
4.1.3 Home position registration by manual recording

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 in tandem with any modifications made by teaching, and the absolute position is now registered. Unlike the program reference system, a 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.)**

4.1.4 Home position registration by numeric input

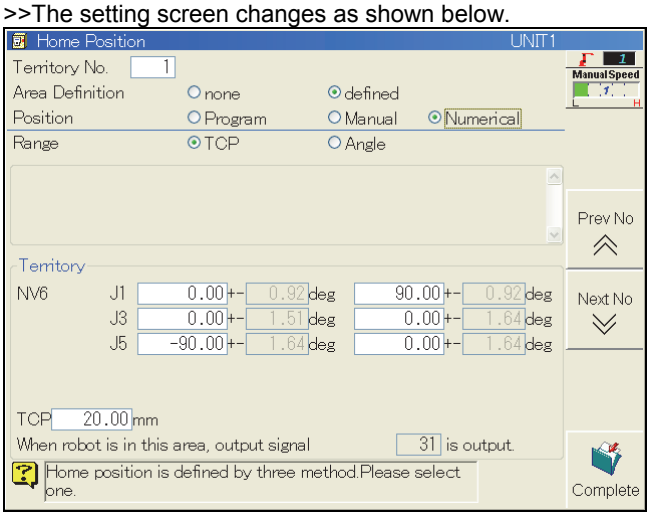
This method is used to record the home position directly without referencing the program. Key in the position data directly from the teach pendant.

The home position registration is not changed in tandem with any modifications made by teaching, and the absolute position is now registered. Unlike the program reference system, a 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.)**

4.2 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 4.3.2 Unit READY signal.

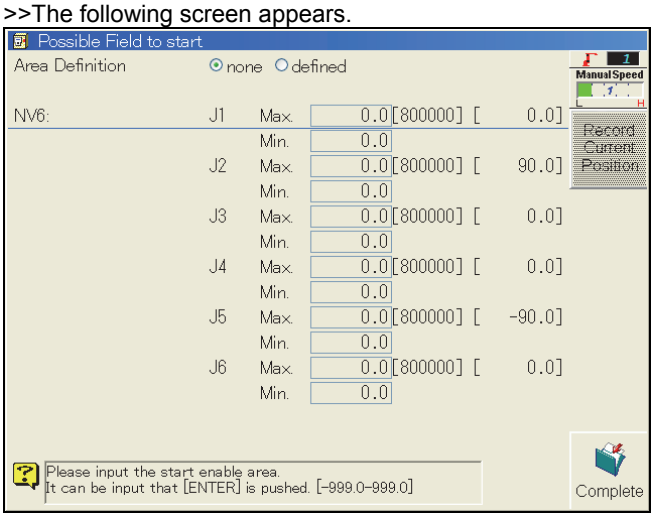
The start enable area can be registered to the mechanism one to one. When all the mechanisms included in a unit are in the registered area, the unit is considered within the range of start enable area. For the management unit, all the mechanisms in a system are to be checked.

4.2.1 Registering the start enable area

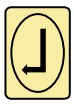
Note that the operator qualification of ***EXPERT*** or higher is required for this operation.

1 Select the teach mode.

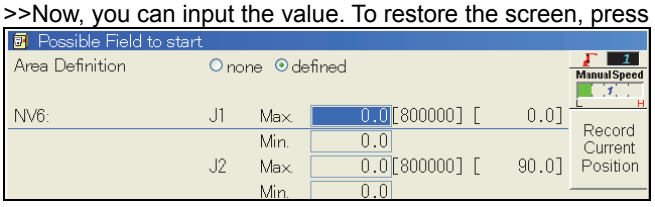
2 Select <Constant Setting> - [9 Area] – [3 Possible Field to start].
>>The following screen appears.

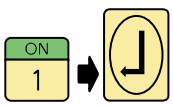


3 Align the cursor with “Area Definition” and press [Enable] + [Right/Left] key at a time to move the radio button to “defined”.

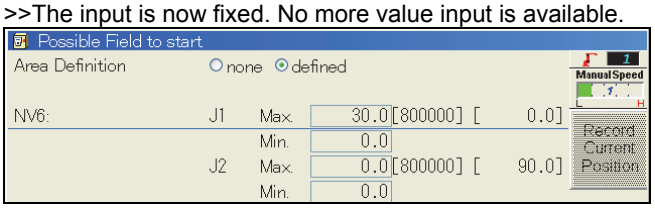


4 Move to the axis to set the area, and press [Enter] key.
>>Now, you can input the value. To restore the screen, press [Enter] key again.



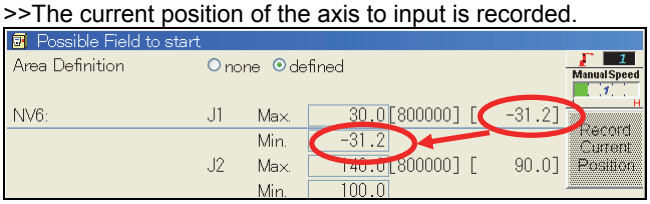


5 When the value input is available, enter the area to set and press [Enter] key.
>>The input is now fixed. No more value input is available.

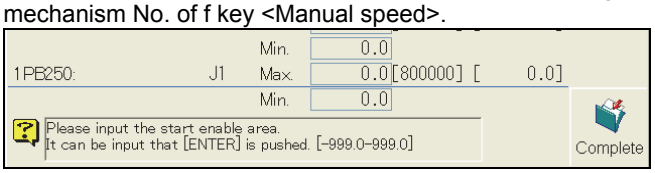


For the rotation axis, specify the area within the range of -999.0 ˚ – 999.0 ˚. For the slide axis, -9999.9mm – 9999.9mm.
The axis, of which both "Max." and "Min." have been set at 0.0, is not to be checked whether it is in the start enable area or not.

6 **When the value input is available, press f key <Record Current Position>.**
>>The current position of the axis to input is recorded.



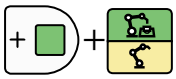
7 **Press [UNIT/MECHANISM] key to move to the next mechanism.**
>>The cursor moves to the first axis of the following mechanism, renewing the mechanism No. of f key <Manual speed>.



8 **After inputting the start enable area, press f key <Complete>.**
Thus, the setting is complete.

4.2.2 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".**

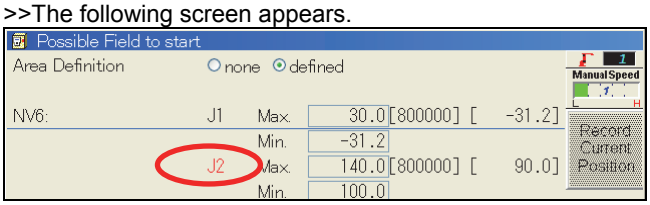
If not, this icon does not appear.

4.2.3 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.

4.3 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.

4.3.1 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 to serve 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.

4.3.2 Unit READY signal

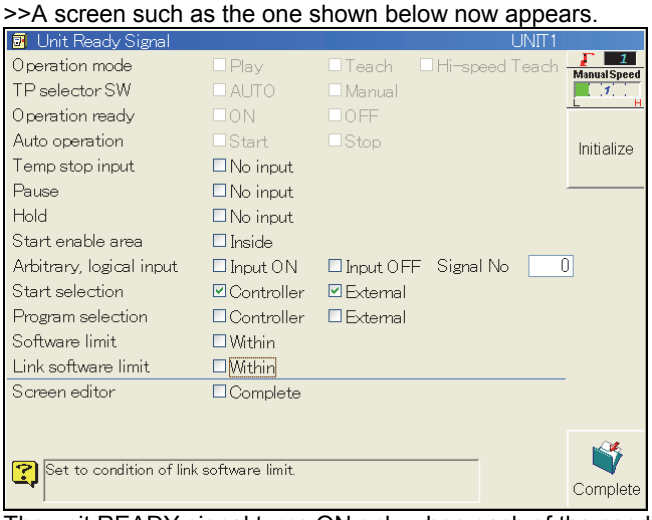
This level signal is output in a status in which the auto operation (starting in playback mode) is acknowledged. The robot cannot be started unless the conditions are met. (This controller itself will not accept start.) This signal has been assigned as a standard signal to serve as one of the basic output 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.

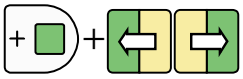
Generating the unit READY signal

1 **Select the teach mode.**

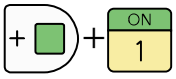
2 **Select <Constant Setting> - [6 Signal attributes] - [4 Unit Ready Signal].**
>>A screen such as the one shown below now appears.



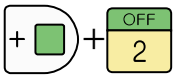
The unit READY signal turns ON only when each of the conditions listed vertically has been met. It remains OFF when even one condition has not been met.



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.

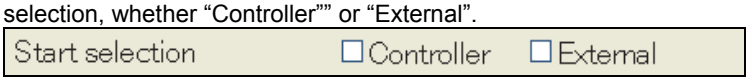


If the item is not going to serve as an ON condition, press [ENABLE] + [OFF] keys.
>>This will remove the check mark from the box. It is acceptable to place more than one check mark inside a horizontal row of boxes. It is also acceptable for no check marks to be placed inside the boxes.

(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.

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”.



For the details of each condition, see Table 4.3.1.

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.

POINT

Prior to shipment from the factory, no checkmark should be placed in any of the check boxes.
This means that the unit READY output signal is always ON by the initial setting.

POINT

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 4.3.1 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 pose input signal.	○
Hold	No input: The condition is met without any pose 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-stationt”. (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 “4.2 Registering Start Enable Area” and follow the procedures to register the start enable area.

4.3.3 Status output signals

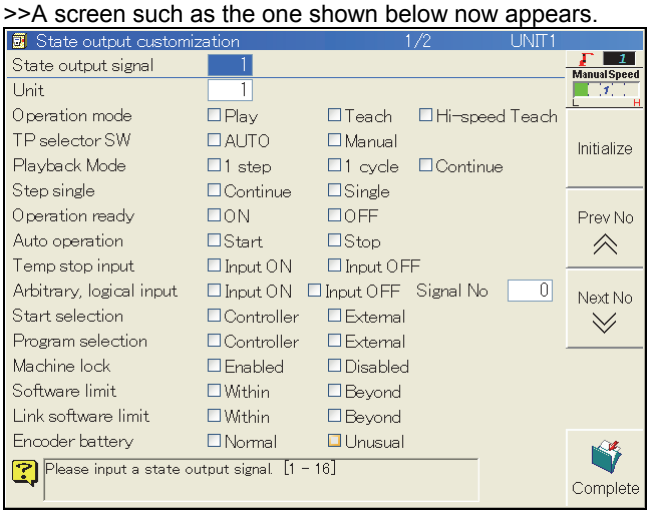
A signal known as a "status output" signal can be created by combining a number of statuses as desired. Unlike the unit READY output signal described above, controller itself will never fail to accept the start regardless of whether the "status output" signal is ON or OFF.A multiple number of "status 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.

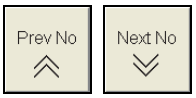
Generating a status output signal

1 Select the teach mode.

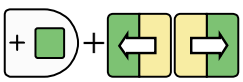
2 Select <Constant setting>-[6 Signal attributes] - [5 State output customization].
>>A screen such as the one shown below now appears.



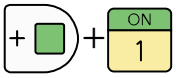
The status output signal turns ON only when each of the conditions listed vertically has been met. It remains OFF when even one condition has not been met.

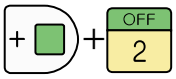


3 Press the [Prev No] or [Next No] f key or input a number in "Status output signal" at the very top of the screen, and press [Enter] key. This enables one of the 16 status output numbers provided to be selected.



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 4.3.2.

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 4.3.2 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	The teach pendant selector switch is not installed as a standard specification. 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 classification class is ***USER*** or below. ***EXPERT*** or above: The condition is met when the current operator classification 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.

4.4 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).

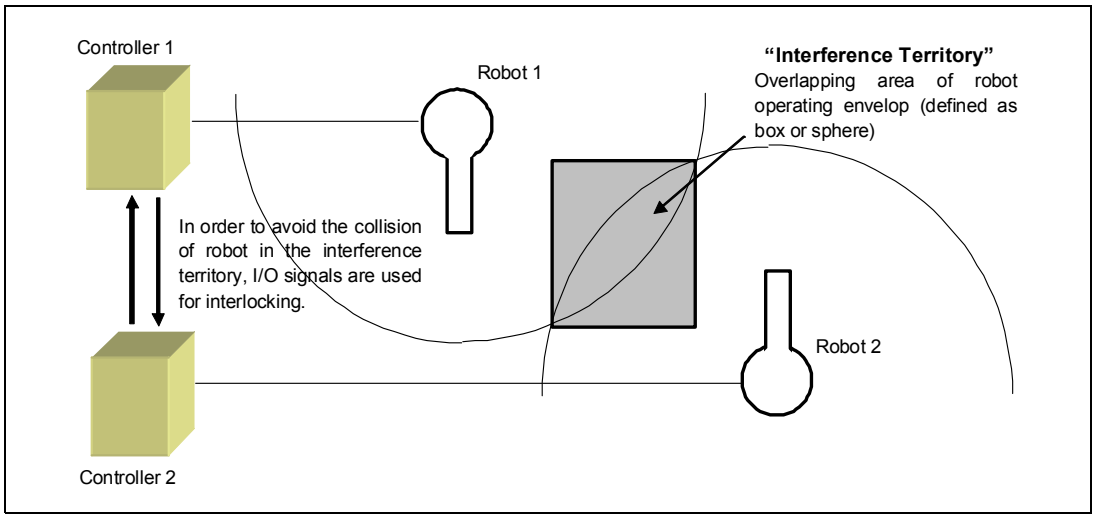


Fig. 4.4.1 Image of Interference Territory

Up to 16 interference territories can be registered per unit (the unit in which the programs is configured).

IMPORTANT

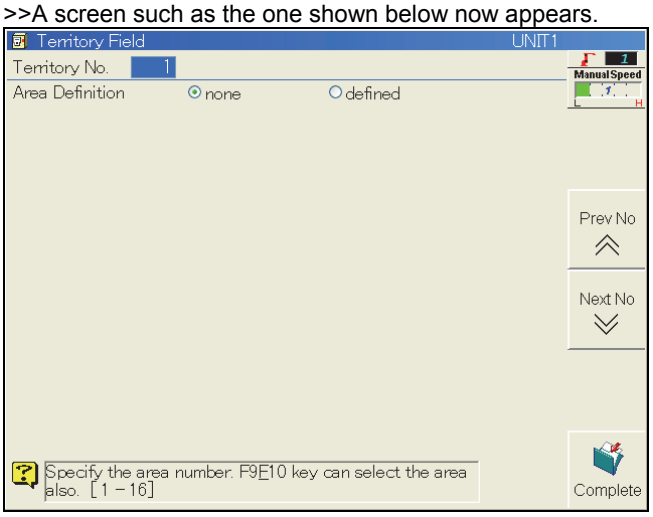
Input / output signals for interference territory are not allocated when shipped.
If this utility is necessary, these signals must be allocated by referring to "3.6 Signal attribute settings".

4.4.1 Registering the interference Territory

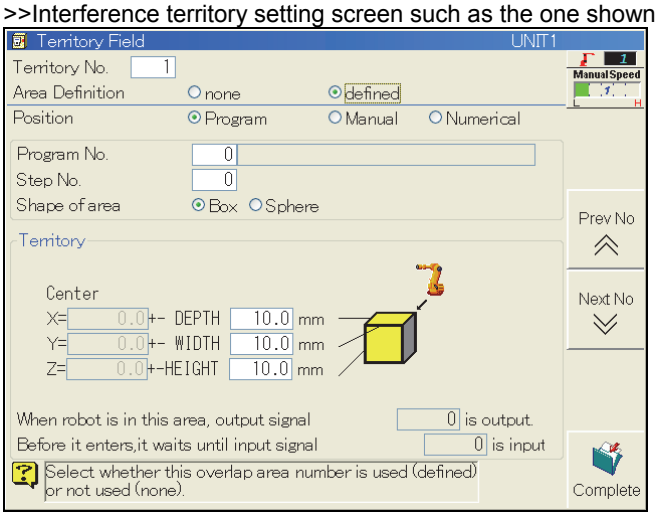
1 **First, teach the position that is the "center" of interference territory using the robot. Select any program, and record the actual position as a step.**

2 **Select the teach mode.**

3 **Select <Constant Setting> - [9 Territory Definition] - [2 Territory Field].**
>>A screen such as the one shown below now appears.

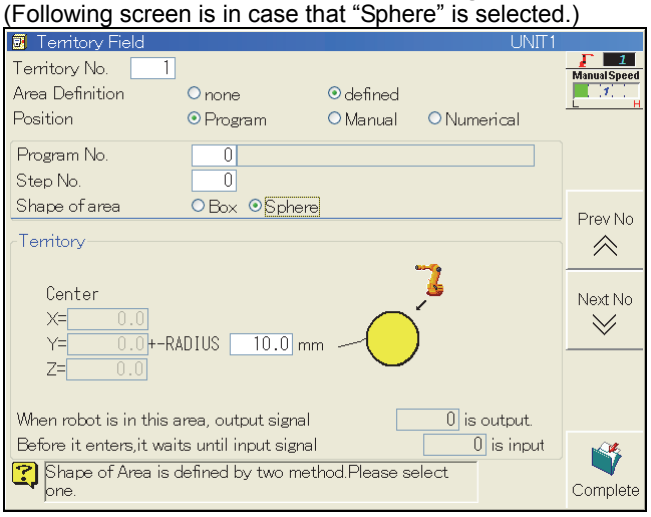


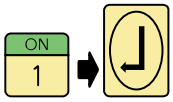
4 **Align the cursor with "Area Definition," and press the [ENABLE] and left or right cursor keys together to set the radio button to "Defined."**
>>Interference territory setting screen such as the one shown below now appears.



5 **Leave the "Position" setting as "Program".**

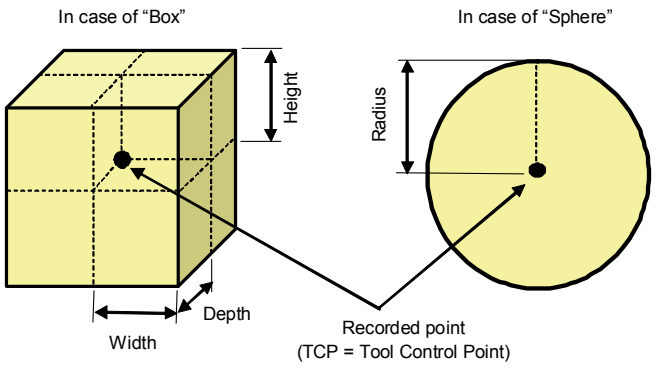
6 **Select either of “Box” or “Sphere” setting as “Shape of area”.**
(Following screen is in case that “Sphere” is selected.)





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**



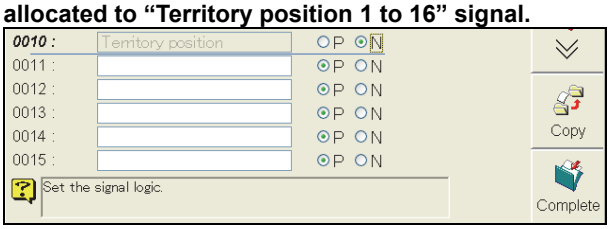
Definition of Interference Territory

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.

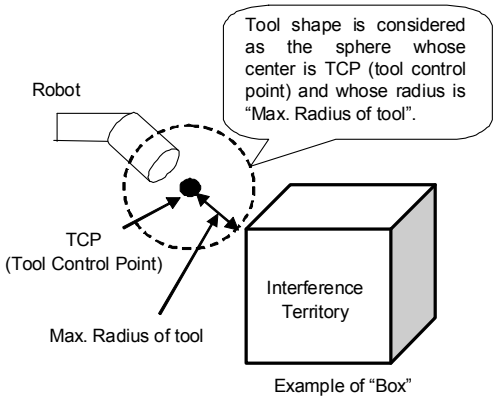


This is a sample screen when output signal No.10 is allocated to "Interference area".

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

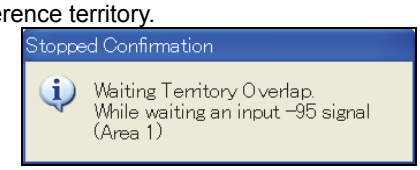
7 **When set to "Manual" :**
Move the robot by manual operation to the center position of interference territory , and press f11 < Record Current Position. > key.
Current position is read from the robot encoder, and the position data is displayed in the center.

When set to "Numerical" :
Directly key in the XYZ value in "Center" of interference territory.

4.4.2 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.

NOTE

Chapter 5 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.

5.1 Outline

5.1.1 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.

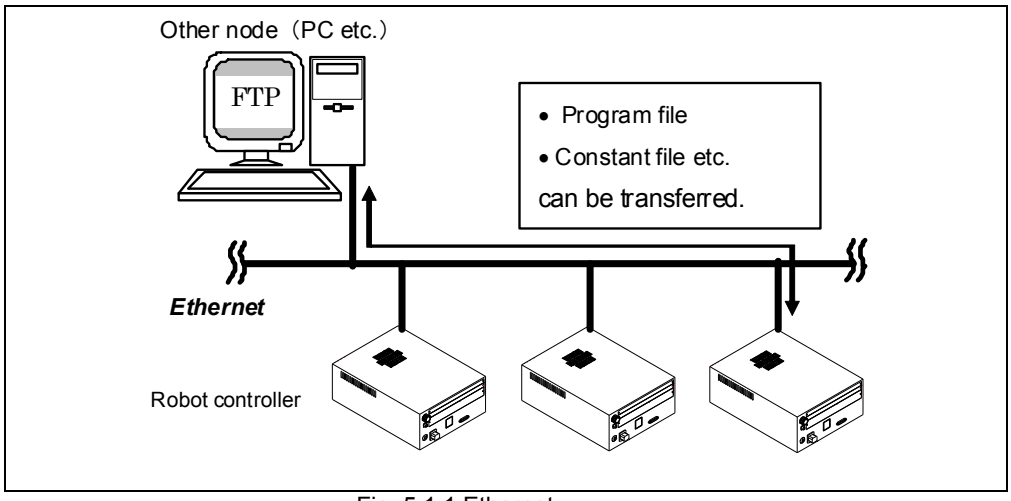


Fig. 5.1.1 Ethernet

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.

5.1.2 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 5.1.1 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.

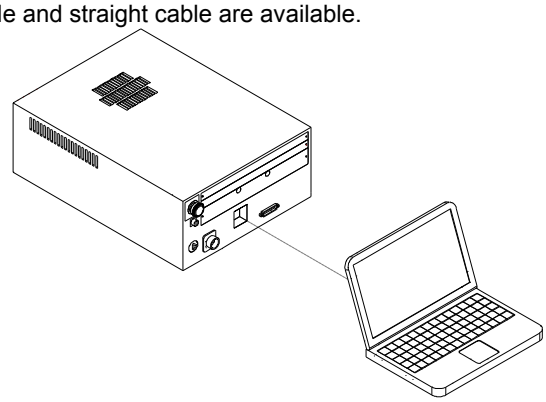
File transfer between the node and this controller through the network will be available, when the setting according to the setting method in "5.1.2 Network setting" is completed and this controller is correctly recognized on the network.

IMPORTANT

Input each selection value such as IP address and subnet mask manually.

5.1.3 Connection of Ethernet cable

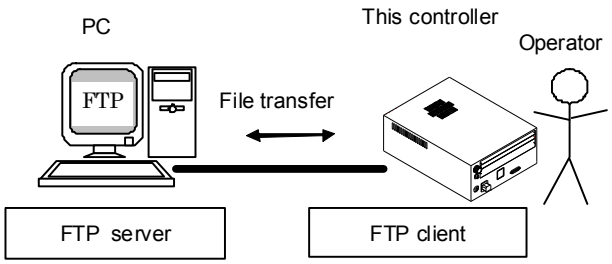
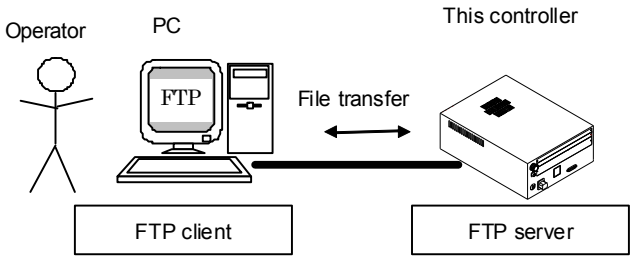
Connect the PC and the LAN port of this robot controller using Ethernet cable.
Both of cross cable and straight cable are available.



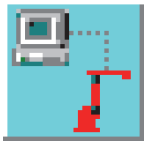
5.1.4 File transfer process

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 5.1.2 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.



5.2 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 license of ***SPECIALIST*** is necessary.

Table 5.2.1 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 “5.2.1TCP/IP setting” or “5.2.2 FTP setting”.

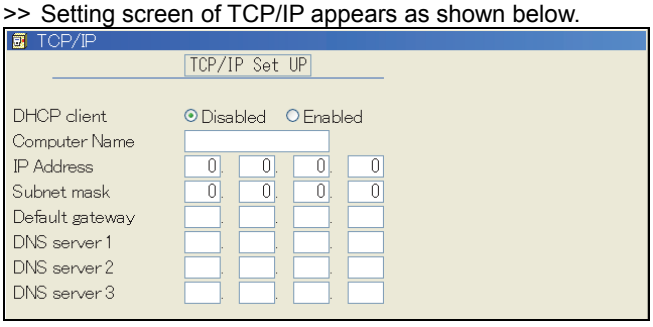
(1) Change the operator qualification to ***EXPERT*** or higher.
(2) Proceed to <Service Utilities> - [13 System Environments].
(3) Check the setting of System Memory Protection Function

5.2.1 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 8.2.2 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 5.2.2 TCP/IP setting

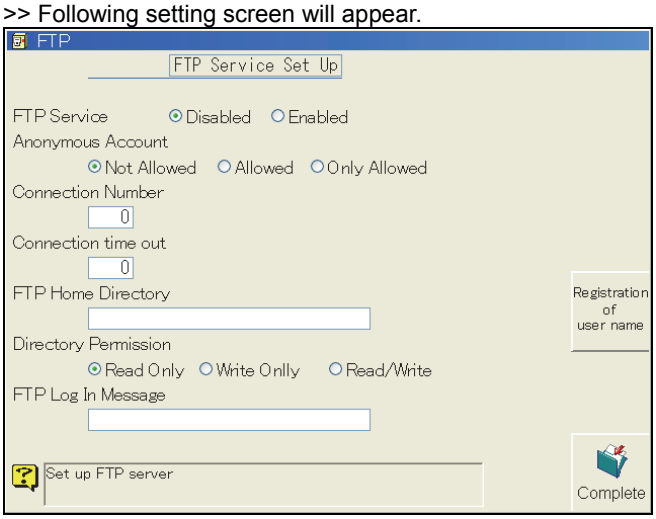
Parameter	Description
DHCP client	Sets whether to use [DHCP client function] of this controller. When "Enabled" is selected, this controller sends DHCP requirement to the network at the time of power ON. When the DHCP host on the network responds, IP address, subnet mask, default gateway, and three or 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.

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.

5.2.2 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 5.2.3 FTP setting**".**

3 **When the setting is completed, press f12 <Complete>.**

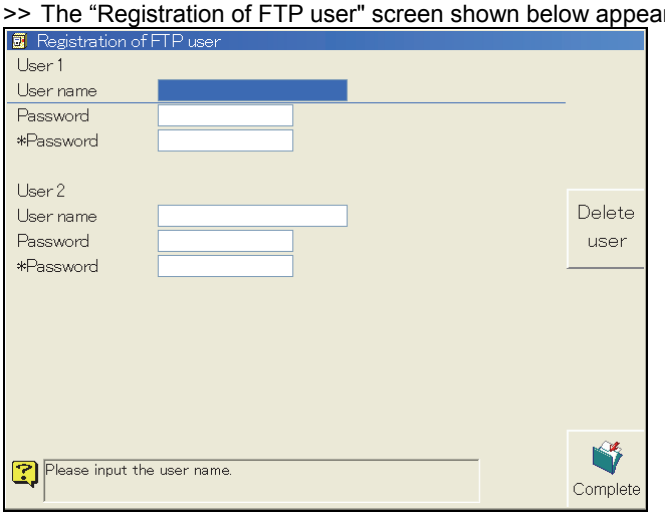
4 **To enable the new settings, restore the power of the robot controller.**

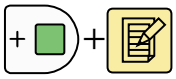
Table 5.2.3 FTP setting

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 16 to 1000.
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.





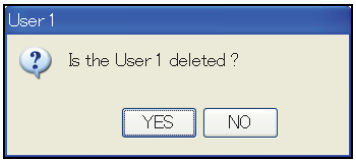
2 **Point the cursor with “User name” and input the user name which is admitted to login.**
For inputting character strings, press [ENABLE] and [EDIT] keys together to open the soft keyboard.

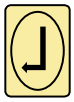
3 **Point the cursor to “password” and then input the password.**

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 the User deleted, 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.

5.3 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 shall be completed beforehand. The details are given in "5.2 Ethernet setting".

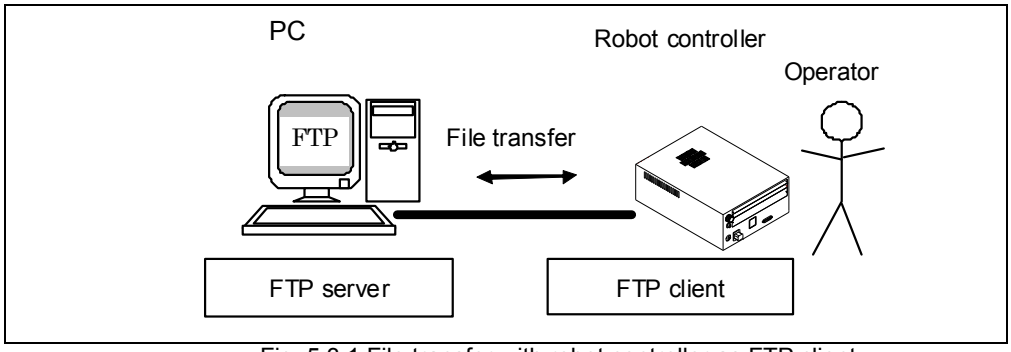


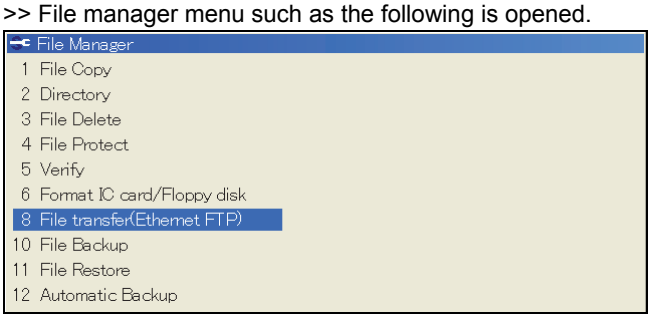
Fig. 5.3.1 File transfer with robot controller as FTP client

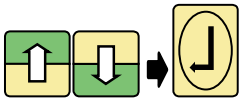
5.3.1 Registrations of FTP Server (Host)

Before using the FTP client function, it is necessary to set a host, which will be the FTP sever 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 qualification as the ***SPECIALIST*** is necessary.

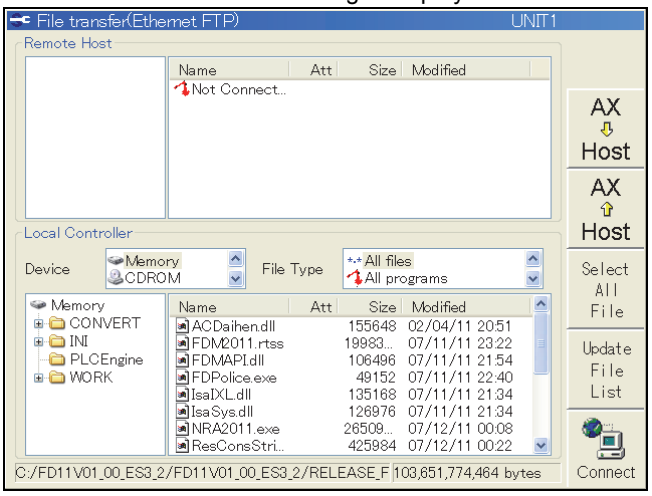
Registrations of FTP Server (Host)

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.

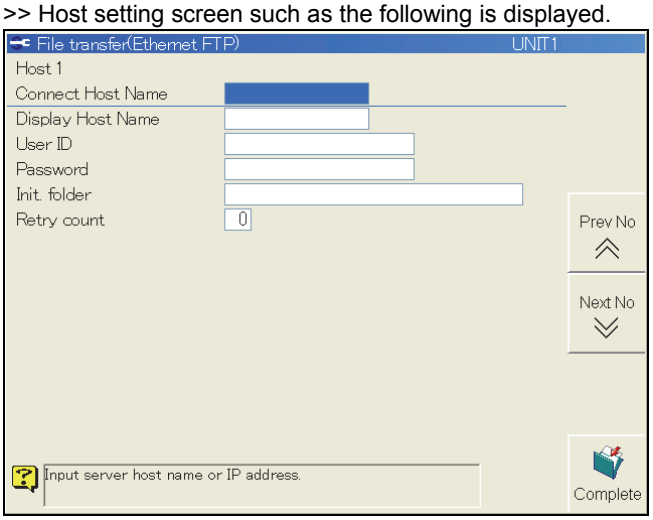




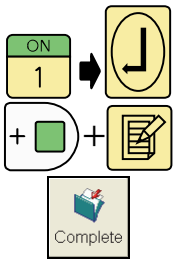
2 **Align the cursor on the [8 File Transfer (Ethernet FTP)] and press [Enter] key.**
>> A screen such as the following is displayed.



3 **Press f7 <Setting of Host>.**
>> Host setting screen such as the following is displayed.



4 **Refer to Table 5.3.1 Host setting 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 5.3.1 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.

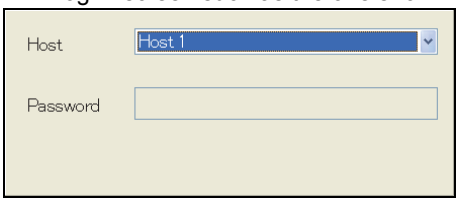
5.3.2 File download

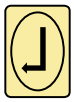
Remote files are copied to the local computer (this controller).
Only qualified operators above ***EXPERT*** may perform this operation.

File Download

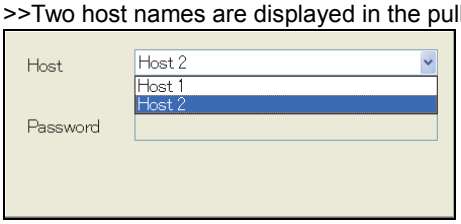
1 to 2 Perform the same operation as "5.3.1 Registrations of FTP Server (Host)".

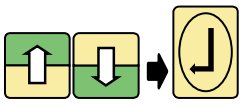
3 Press f12<Connect> to connect to the FTP server.
>> A log-in screen such as the one shown below appears.



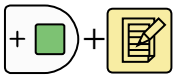


4 Position the cursor on the host selection column and press the [Enter] key.
>>Two host names are displayed in the pull-down menu as shown.

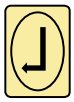


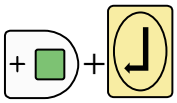


5 Select the host for connection with [Up] or [Down] keys and press the [Enter] key.



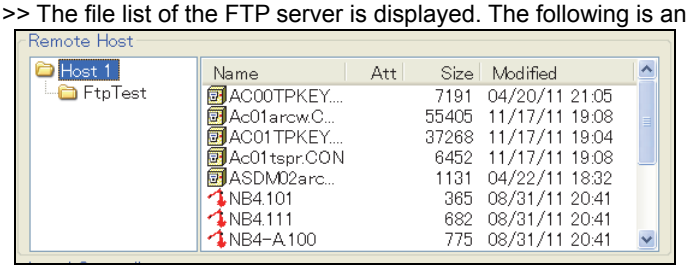
6 Input the password for logging in to the FTP server in the "Password" field.
If the user ID is set to "Anonymous," leave this field blank.
For inputting character strings, press [ENABLE] and [EDIT] keys together to open the soft keyboard.

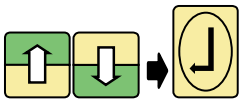




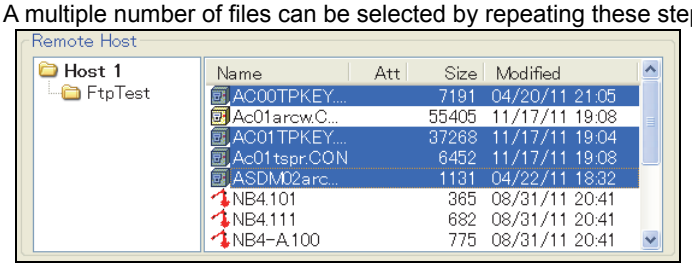
7 When the cursor is in the password column, press the [Enter] key. When the cursor is in the host column, press the [ENABLE] key and the [Enter] key.
The host is connected to the specified FTP server.
Login screen is closed automatically.

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 "5.3.1 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.



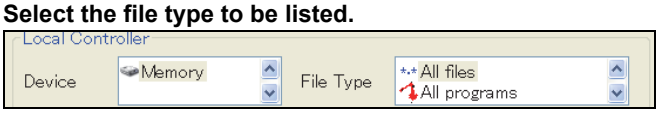
To release the selected status, select the file to be released, and press [BS].

To select all files, press the f10<Select All File>.

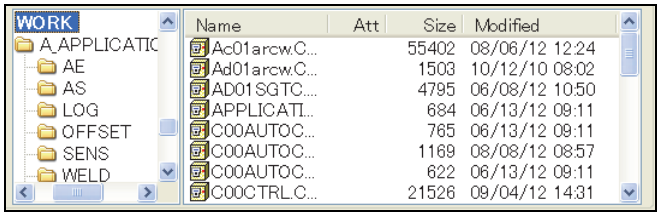
When the all file selection mode is reset, press the <Release All File> (ENABLE + f10).

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.

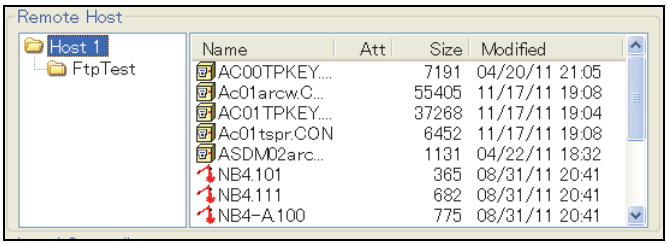
5.3.3 File upload

Copy local files into the remote computer as described below.
Only qualified operators above ***EXPERT*** may implement this process.

File Upload

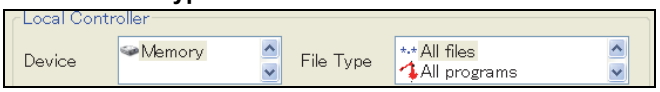
1 to 8 Perform the same process as download from step 1 to 8.

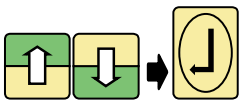
9 At the remote host, select the folder to which files are transferred.



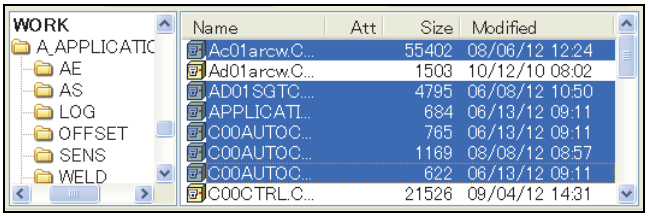
10 At the device selection field of the local controller, select the device.

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.

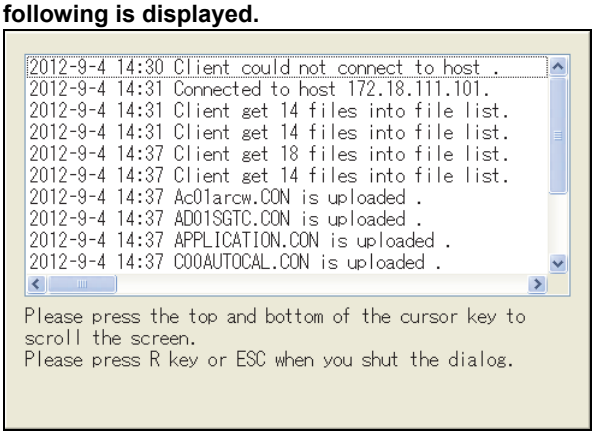
14 When the necessary file transfer is completed, press [RESET/R] to exit the menu.

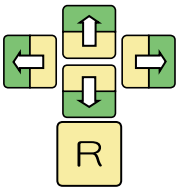
5.3.4 Referent Log

Record of communication with the FTP server is referenced.
This operation should be carried out by the qualified operator of the ***SPECIALIST*** qualification or above.

2 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 5.3.2 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.

5.4 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 "5.2 Ethernet setting".

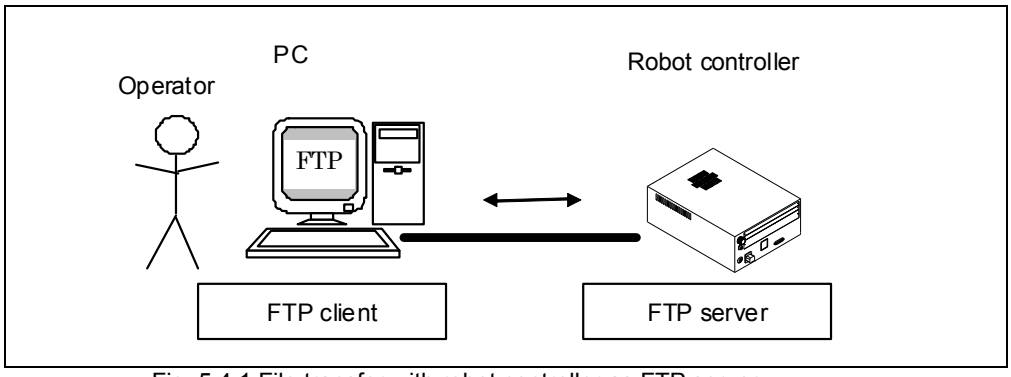


Fig. 5.4.1 File transfer with robot controller as FTP server

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

Chapter 6 Initial setting with Compact TP

This chapter describes the setup operations using the Compact Teach Pendant.
For the setup operations that are not available in case of Compact TP, please refer to the other chapters. (In that case, “FD on Desk Light” is necessary.)

6.1 Setup of the robot

6.1.1 Encoder reset and encoder correction

In the following cases, the encoder reset and the encoder correction is required.

- The robot was replaced with other one.
- The encoder battery in the robot was replaced.
- Encoder related error occurs
- The encoder reference position is incorrect

For other cases, it is not necessary to execute the encoder reset and the encoder correction. If those operations are performed carelessly or in wrong way, the work programs in the robot controller may not be able to run correctly because the each axis's reference position changes.

The encoder reset is an operation to initialize the encoder unit itself. And the encoder correction is an operation to determine the reference position of each axis. Both of these operations are very important operations to make the robot work correctly.

When performing the encoder correction, these 2 points are important.

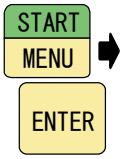
(1) This operation must be done with the actual all loads (tools and additional loads on the arm) must be installed in advance.
(2) This operation must be done before starting the teaching operations (programming).

If the encoder correction is performed after making the teaching programs, it may become impossible to run the work programs correctly because the reference position of each axis may shift.

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 safe corridors. If this procedure is omitted, operator may be caught or sandwiched by the robot parts, possibly resulting in death or serious injury.

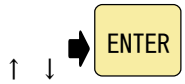
Encoder reset

1 **Select the TEACH mode.**
And lock the [EMERGENCY STOP BUTTON].



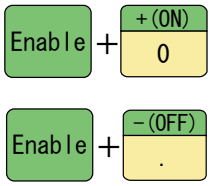
2 **Open the [START / MENU] - <ROBOT> menu.**
In this screen, the encoder correction and the encoder reset can be selected.

```
*MENU*                                  V3.07
<ENCRESET>
 ENCCORRE
>
```



3 **Set the cursor to "ENCRESET" and press [ENTER].**
>> "ENCRESET" setting screen is displayed.

```
*MENU*ENCRESET                    V3.07
 J   CURPOS                    oRESET
<1   0 8 0 0 0 0 >
>
```



4 **Select the target axis with cursor keys (up/down) and press [Enable] + [+ / 0].**
>> "o" mark is attached to the selected axis.

```
*MENU*ENCRESET                    V3.07
 J   CURPOS                    oRESET
<3   0 8 0 0 0 0 >              o
>
```

To detach the "o" mark, press [Enable] + [- / .]

5 **After confirming the axis name that is to be resetted, press [ENTER].**
>> A confirmation messge is displayed.

```
*MENU*ENCRESET                    V3.07
 J   CURPOS                    oRESET
<3   0 8 0 0 0 0 >              o
>[1]EXECUTE[R]CANCEL
```

6 **If the [FN / 1] is pressed, the encoder reset will be executed.**
>>If the encoder reset is executed successfully, the screen will return to prompt display.

After completing the encoder reset, proceed with the encoder correction.

When executing the encoder reset, the error status bits and the multi rotation number memory in the encoder will be cleared.

Encoder correction (Position record)

IMPORTANT

There are 2 ways for the encoder correction operation. The 1st one is "Position record" and the 2nd one is "Data input". In the Compact TP, only the "Position record" operation is available.
If the encoder correction operation based on the "Data input" is necessary, Smart TP is necessary.

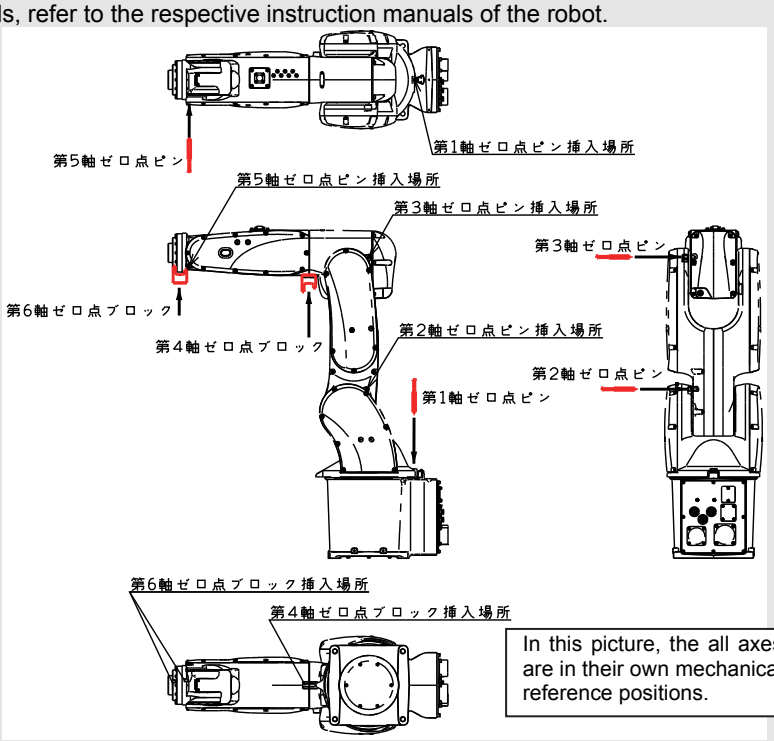
Position record	The current mechanical position is regarded as the encoder reference position (0 degree position) and the encoder correction value will be re-calculated (adjusted) by the robot controller.
Data input	The encoder correction values are to be inputted manually by the operator.

1 **Turn the MOTORS ON in the TEACH mode.**

2 **Move the target axis to its mechanical reference position (center position) with manual operation.**
(Manual speed 2 or 3 is recommended)

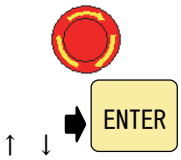
IMPORTANT

To make the mechanical reference position, zeroing pins and zeroing blocks are necessary.
The mechanical reference positions differ from each other depending on the robot type.
For details, refer to the respective instruction manuals of the robot.



Mechanical reference position (in case of MZ07 series)

3 **Press the [EMERGENCY STOP BUTTON].**



4 **Set the cursor to "ENCCORRE" and press [ENTER].**

```
*MENU*                                    V3.07
   ENCRESET
<ENCCORRE>
>
```

>> "ENCCORRE" setting menu is displayed.

```
*MENU*ENCCORR      V3.07
   J   CORRVAL   CURPOS
<1   0 7F83 0>   0 7FF9 C
>
```

(This is just an example screen.)

↑ ↓ ENTER

5 **After checking that the axis is in the mechianical reference position (using the zeroing pin and the zeroing block), set the cursor to the concerned axis and press [ENTER].**
>> The encoder correction value is re-calculated so that the current position turns to the encoder reference position.

```
*MENU*ENCCORRE   V3.07
  J   CORRVAL   CURPOS
<1   07F894>   07FF9C
>
```

ENTER

6 **Press the [ENTER] key.**
>>The prompt display changes like the following picture.

```
*MENU*ENCCORRE   V3.07
  J   CORRVAL   CURPOS
<1   07F894>   07FF9C
>[1]EXECUTE[R]CANCEL
```

FN 1

7 **Press [FN / 1]. The new encoder correction value will be saved to the internal memory.**
>> If the save operation has been finished successfully, the screen will return to prompt display.

CAUTION

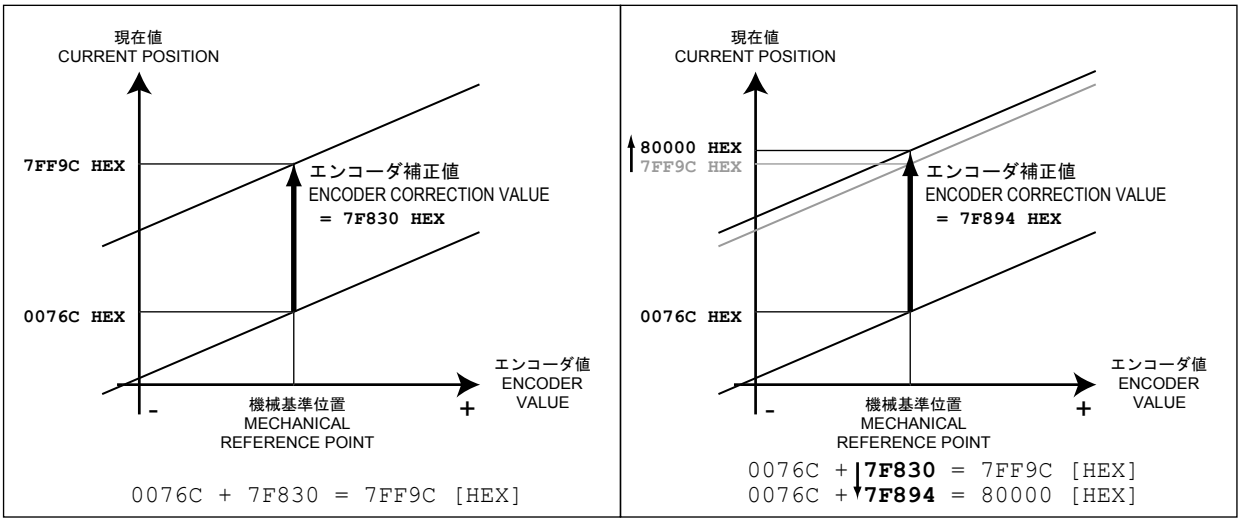
As for the robot using “Zeroing pin and block”, check to be sure that the zeroing pin has been removed and then operate the robot. Note that operating the robot with the zeroing pin inserted may bend the pin or deform the hole for this pin, thus disabling proper positioning of the zeroing pin.

INFO.

- When executing the encoder correction, the current mechanical position is registered as the encoder reference position (that means the encoder correction value for the axis is re-calculated so that the position becomes the encoder center position).

- If the encoder correction is executed at the position except for the mechanical reference position (that is determined via the zeroing pin or zeroing block), the robot cannot move correctly. For example, even if the robot tries to move to the following position, it will move to the incorrect position when the encoder reference position is incorrect.

(J1, J2, J3, J4, J5, J6) = (0, 90, 0, 0, 0, 0)



エンコーダ補正前
BEFORE THE ENCODER CORRECTION

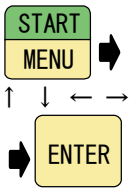
```
*MENU*ENCCORRE   V3.07
  J   CORRVAL   CURPOS
<1   07F830>   07FF9C
>
```

エンコーダ補正後
AFTER THE ENCODER CORRECTION

```
*MENU*ENCCORRE   V3.07
  J   CORRVAL   CURPOS
<1   07F894>   08000 0
>
```

6.2 Setup of the controller

6.2.1 Display language

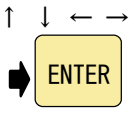


1 **Open [START / MENU] - <SETTINGS> - <LANGUAGE> menu.**

```
*MENU*                              V3.07
 TCP/IP                  FILE
<LANGUAGE>               TP
>
```

>> "LANGUAGE" setting screen is displayed.

```
*MENU*LANGUAGE                      V3.07
<English>                Japanese
 German                  Italian
>[1]Write                [R]RETURN
```



2 **Set the cursor to the desired language and press [ENTER].**

>> The selected language is surrounded by < >.

English → Japanese → German → Italian → Chinese → Spanish → Korean (7 languages)

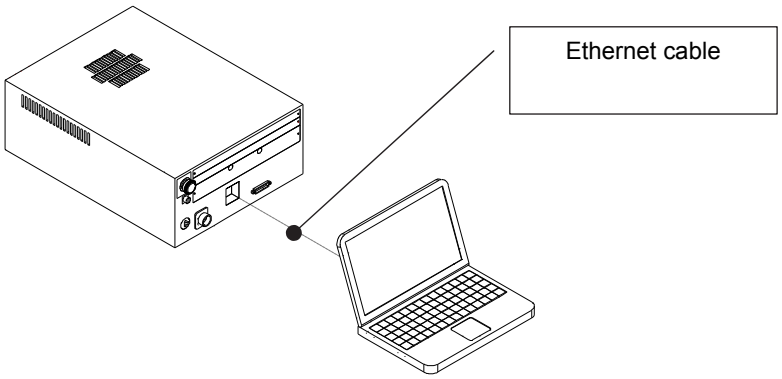
```
*MENU*LANGUAGE                      V3.07
<Chinese>                Spanish
 Korean
>[1]Write                [R]RETURN
```

Japanese is displayed in KATAKANA.
Chinese is displayed in Pin-yin.
And the other all languages are displayed in English.

3 **When [FN / 1] key is pressed, the language is determined.**

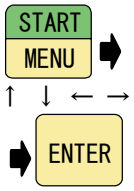
>> The screen returns to prompt display.

6.2.2 Ethernet (TCP/IP)



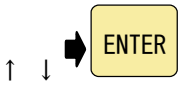
When using "FD on DESK Light", connect the PC and this robot controller with an Ethernet cable and make the settings for the TCP/IP.

TCP/IP setting



1 **Open [START / MENU] - <SETTINGS> - <TCP/IP> menu.**
>> "TCP/IP" setting screen is displayed.

```
*MENU*TCP/IP      V3.07
<IPAddress>   000.000.0
 SubMask      000.000.0
>[1]EXECUTE [2]RETURN
```



2 **Set the cursor to "IP Address" and press [ENTER].**
>> "I1" is displayed at the prompt.

```
*MENU*TCP/IP      V3.07
<IPAddress>   000.000.0
 SubMask      000.000.0
>I1
```

3 **Input the 1st byte of the IP address (0-255) using the numeric keys and press [ENTER]. (Now, "192" is inputted)**
>> "I1 192" is displayed at the prompt.

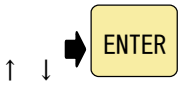
```
*MENU*TCP/IP      V3.07
<IPAddress>   000.000.0
 SubMask      000.000.0
>I1 192
```

4 **Press [ENTER].**
>> "I2" is displayed at the prompt.

```
*MENU*TCP/IP      V3.07
<IPAddress>   000.000.0
 SubMask      000.000.0
>I2
```

5 **Repeat 3 and 4 to input to the 4th byte and press [ENTER].**
>> The inputted address is displayed as "IPAddress".

```
*MENU*TCP/IP      V3.07
<IPAddress>   192.031.0
 SubMask      000.000.0
>[1]EXECUTE [2]RETURN
```



6 **Set the cursor to the "SubMask(Sub net mask)" and press [ENTER].**
>> "I1" is displayed at the prompt.

```
*MENU*TCP/IP      V3.07
 IPAddress    192.031.0
<SubMask>     000.000.0
>I1
```

ENTER

7 **Input the 1st – 4th byte in the same way with the IP address and press [ENTER].**
>> The inputted values are displayed at the "SubMask".

*	M	E	N	U	*	T	C	P	/	I	P				V	3	.	0	7
	I	P	A	d	d	r	e	s			1	9	2	.	0	3	1	.	0
<	S	u	b	M	a	s	k		>		**2**	**5**	**5**	**.**	**2**	**5**	**5**	**.**	**2**
>	[	1	]	E	X	E	C	U	T	E	[	2	]	R	E	T	U	R	N

→

8 **Press right cursor key.**
>> The setting value of the cursor position is displayed in scroll.

*	M	E	N	U	*	T	C	P	/	I	P				V	3	.	0	7
	I	P	A	d	d	r	e	s			1	9	2	.	0	3	1	.	0
<	S	u	b	M	a	s	k		>		**5**	**.**	**2**	**5**	**5**	**.**	**0**	**0**	**0**
>	[	1	]	E	X	E	C	U	T	E	[	2	]	R	E	T	U	R	N

FN
1

9 **Press [FN / 1]. A message like the following screen will be displayed.**

*	M	E	N	U	*	T	C	P	/	I	P				V	3	.	0	7
	I	P	A	d	d	r	e	s			1	9	2	.	0	3	1	.	0
<	S	u	b	M	a	s	k		>		5	.	2	5	5	.	0	0	0
>	P	l	e	a	s	e		P	o	w	e	r			O	f	f		

To enable the settings, turn OFF the controller main power.

INFO.

A setting example is shown below.

PC side settings

IP Address	192	168	1	1
SubMask	255	255	255	0

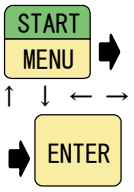
CFD side settings

Input prompt name	I1	I2	I3	I4
IP Address	192	168	1	2
SubMask	255	255	255	0

In this example, both the PC and the CFD belong to the identical network (address = 192.168.1.0).

6.2.3 Teach pendant setting (LCD Contrast)

It is possible to change the Compact TP's LCD contrast. Normally, it is not necessary to change the factory setting.



1 **Open [START / MENU] - <SETTINGS> - <TP> menu.**
>> "TP" setting screen is displayed.

```
*MENU*TP                    V3.07
<CONTRAST>          04

>
```

2 **Set the cursor to "CONTRAST" and press [ENTER].**
>> "C" is displayed at the prompt.

```
*MENU*TP                    V3.07
<CONTRAST>          04

>C
```

3 **Input the desired contrast using the numeric keys (from 0:Dark to 7:Light) and press [ENTER]**
>> The contrast setting is changed.

```
*MENU*TP                    V3.07
<CONTRAST>          02

>
```

Chapter 7 Synchro-motion function setup

This chapter describes the setup operations of the Synchro-motion function.

7.1 Outline

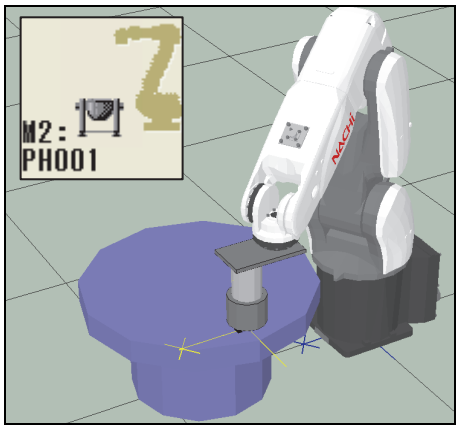
The ***"Synchro-motion"*** is a function to make a certain mechanism follow the motion of the other mechanism in the same UNIT.

(Example of the mechanism configuration) 2 mechanisms belong to 1 UNIT

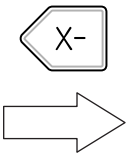
Mechanism No.	Mechanism	Setting
M1	MZ07-01	- Speed standard mechanism - Non-Operation standard mechanism
M2	PH001	- Operation standard mechanism

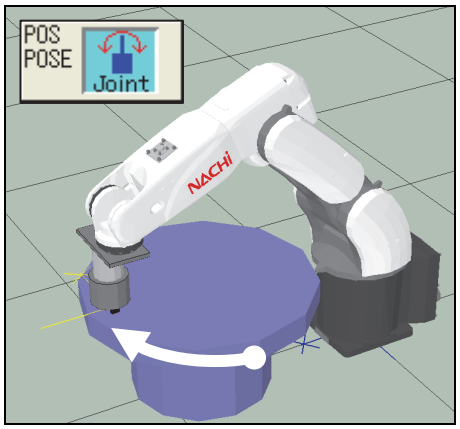
In this example, when the positioner rotates, the robot will move following the motion of the positioner. In this case, the positioner and the robot are in the relation-ship of *"Master-servant relationship"*. The positioner is the "Master" mechanism and the robot is the "Servant mechanism". And, there are ***"Position and Posture synchromotion"*** and ***"Position synchromotion"***. These 2 operations can be selected when operating the robot manually.

Manual rotation of the positioner in the *"Position and Posture synchromotion"*



Positioner angle is 0 degree

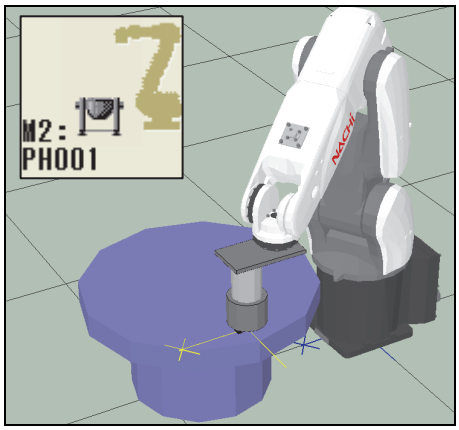




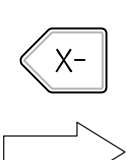
90 degrees rotation

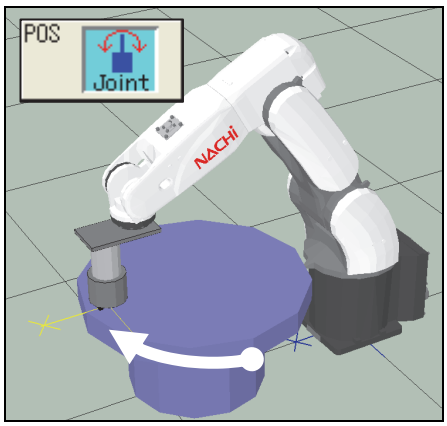
The robot position moves following the positioner
Tool posture also follows the positioner

Manual rotation of the positioner in the *"Position synchromotion"*



Positioner angle is 0 degree





90 degrees rotation

The robot position moves following the positioner
Tool posture does not follow the positioner

POINT

- This function (Synchro-motion) is available in the System software version FDV04.11 or after. The system software version is displayed in the menu of <Service Utilities> [13 System Version].

- The Enable/Disable setting of this Synchro-motion function is initialized at the timing of memory format operation. So, the enabling operation must be done after finishing the memory format operation.

- The all mechanisms to be controlled by the Synchro-motion must belong to the identical “UNIT” and connected to the identical robot controller (CPU).

-The master mechanism must be set as the ***“Operation standard mechanism”***.

7.2 Setting procedure

7.2.1 How to initialize the memory of the controller (outline)

IMPORTANT

- Normally, the memory format operation (e.g. registration of mechanisms, creation of a UNIT, encoder offset setting, etc.) is completed at the timing of the shipping from our factory. If there are no special reasons, the setting procedure in this section can be skipped and you can proceed with the ***"7.2.2 Enabling the Synchro-motion function"***.

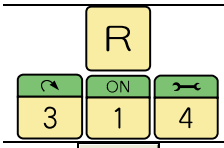
- When the memory format (initializing) operation is executed, the internal memory of this robot controller is initialized and the encoder correction values (offset values) will be cleared also. Therefore, if necessary, make a note of those offset values in advance and input those values manually after finishing the memory format operation. The encoder offset values are displayed in the following screen in decimal values.

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

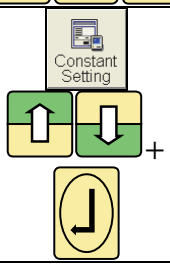
In this example, the memory format will be executed using the mechanism configuration shown in the previous section.

Setting procedure

1 Select the Teach mode.



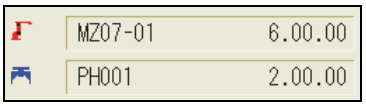
2 For this setting operation, ***SPECIALIST*** is necessary as the operator level.
Change the operator level using the Shortcut command R314 in advance.
(The initial parameter is "12345")

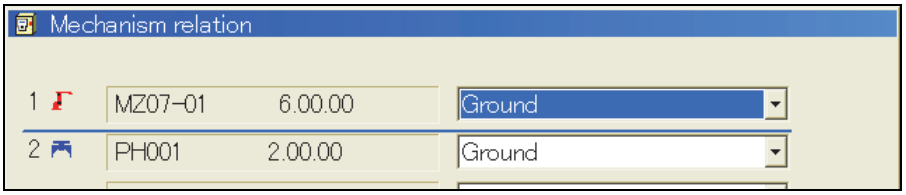


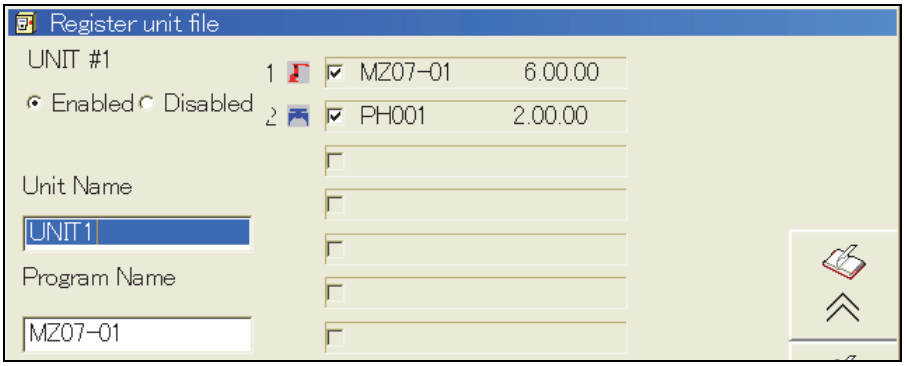
3 Open the <Constant Setting> - [12 Format and Configuration] [1 Format].

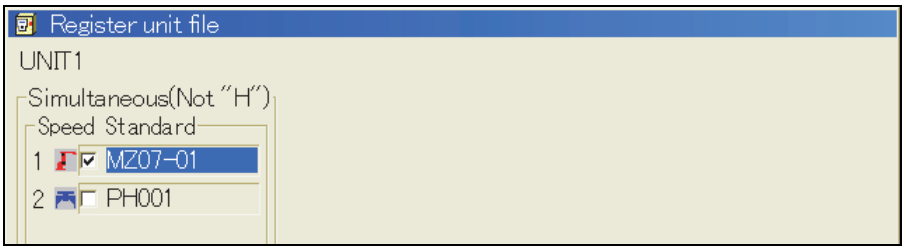
4 Start the memory format operation with the following settings.

For details about the operation, refer to the following instruction manual.
"FD CONTROLLER INSTRUCTION MANUAL : Memory format procedure" (TFDEN-094)

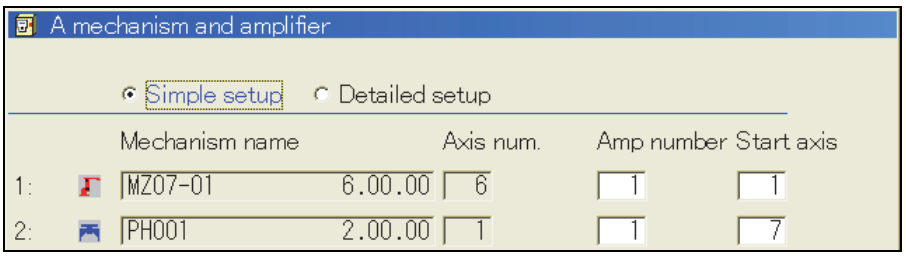




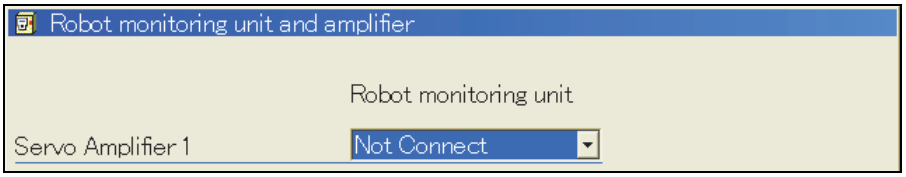




The setting in this screen will be changed after enabling the Synchro-motion function.



In case of 1 additional axis specification (6-axes robot + 1 axis rotational positioner, total 7-axes), make the setting like this picture.

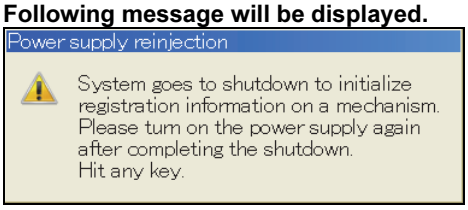


When RMU (Robot Monitoring Unit) is used
Select *"Connect"*.

When RMU (Robot Monitoring Unit) is not used
Select *"Not Connect"*.

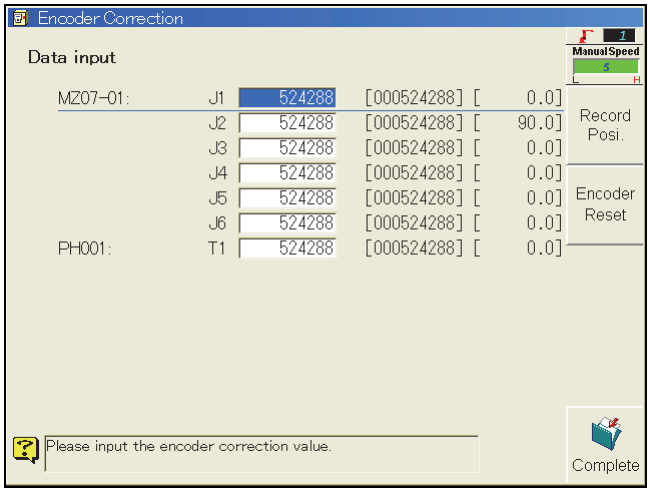
If it is not clear which setting should be selected, please contact our service center.

5 **Following message will be displayed.**



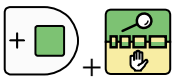
6 **Press any key of the teach pendant and wait until the shutdown process is completed.**
Do not turn OFF the power until the shut down completion message is displayed.

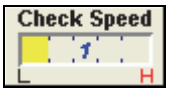
7 **When the shut down is completed, turn OFF the power and turn ON it again.**
>>The following screen will be displayed. If necessary, input the encoder correction values (offset values) manually and press <Complete> key to save.



8 **After executing the memory format operation, the manual speed and the check go speed is level 1. Please select the other speed.**

(Except for 1)





("5" is recommended)

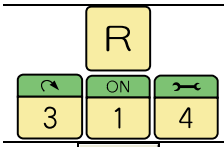
9 **Now the memory format procedure is completed.**
Proceed with the next section.

7.2.2 Enabling the Synchro-motion function

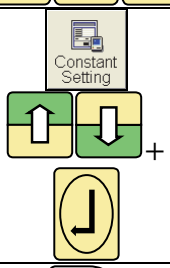
Enable the “Synchro-motion” function.

Setting procedure

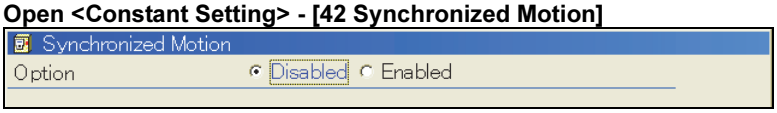
1 **Select the Teach mode.**

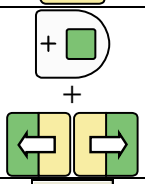


2 **Select the user level *EXPERT* or higher using the Shortcut code R314.**
(NOTE)
The initial password for the ***EXPERT*** level is not set. Just press [Enter] key.

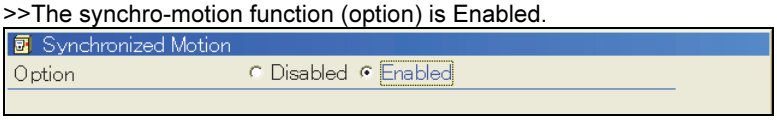


3 **Open <Constant Setting> - [42 Synchronized Motion]**





4 **Press [Enable] + [→]**
>>The synchro-motion function (option) is Enabled.



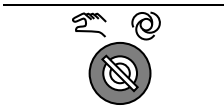
5 **Press F12 <Complete>**
>>The setting is saved in the internal memory. Then, by pressing any key, the shut down process will start automatically.

7.2.3 Setting the “Operation standard” and the “Speed standard”

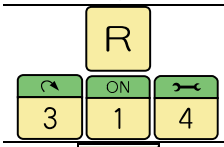
Set the ***“Operation standard mechanism”*** and the ***“Speed standard mechanism”***.

(See also)
“7.3.4 What is the “Operation standard mechanism” ?”
“7.3.5 What is the “Speed standard mechanism” ?”

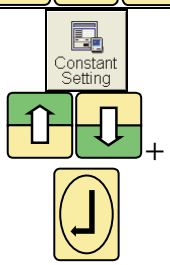
Setting procedure



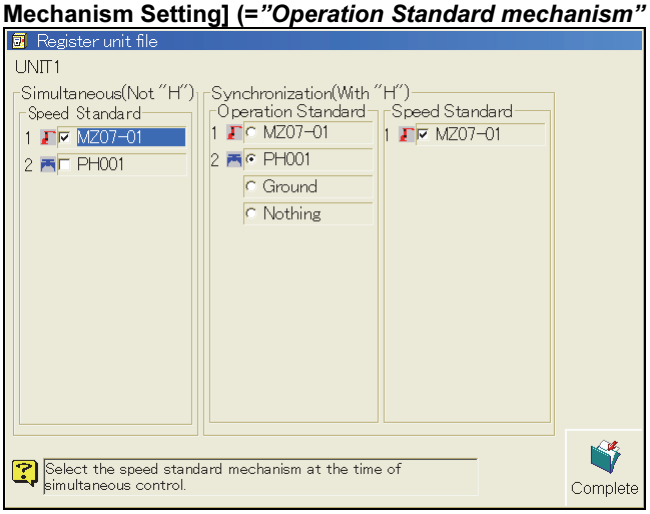
1 **Select the Teach mode.**



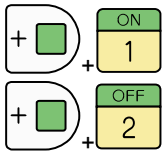
2 **Select the user level *EXPERT* or higher using the Shortcut code R314.**
(NOTE)
The initial password for the ***EXPERT*** level is not set. Just press [Enter] key.



3 **Open the <Constant Setting> - [12 Format and Configuration] [19 Based Mechanism Setting] (=*”Operation Standard mechanism”* setting)**

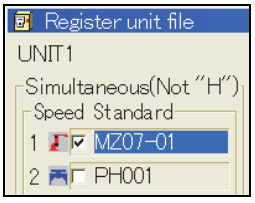


4 **<Simultaneous (Not “H”)>**
This side is the setting for “Simultaneous control”.
(The control in which the Synchro-motion is not executed)

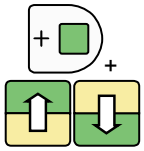


Set the ***“Speed Standard mechanism”***.

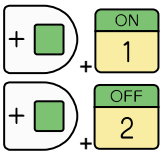
Turn ON/OFF the check-mark with [Enable] + [1](ON) or [2](OFF).
In this case, put the check-mark only for the Mechanism 1 “MZ07-01”.



5 **<Synchronization (With "H")>**
This side is the setting for Synchro-motion.
(The control in which the Synchro-motion is executed)



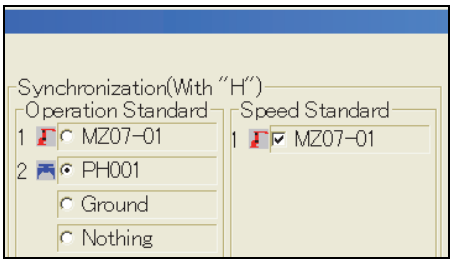
Operation standard Mechanism
The mechanism can be selected by [Enable] + cursor keys (up/down)



Speed Standard Mechanism
The check mark can be turned ON/OFF with [Enable] + [1](ON) or [2](OFF).

In this example, please make the setting like this.

Operation Standard : PH001 (positioner)
Speed Standard : MZ07-01(robot)

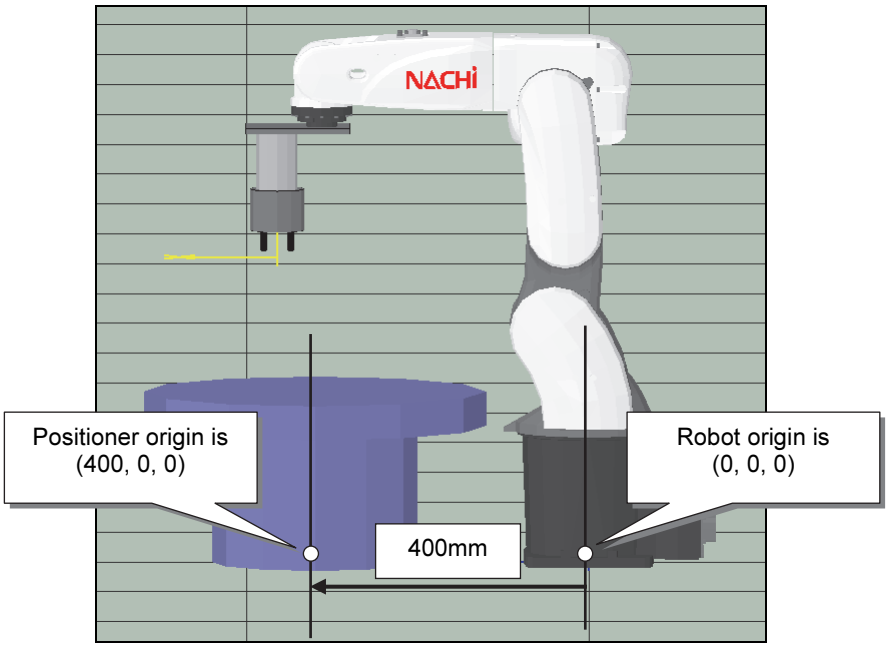


6 **Press F12 <Complete>. A confirmation message is displayed. Select [YES] and press [Enter].**
>>The setting is saved in the internal memory. Then, by pressing any key, the shut down process will start automatically.

7.2.4 Setting the installation position and the angle of the mechanisms

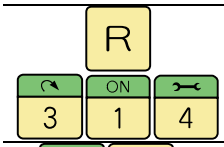
For the Synchro-motion control, the data of the position and the angle of each mechanism is necessary. Set those parameters following the procedure shown below.

In the example of this chapter, the positioner is placed at the position of (X, Y, Z) = (400, 0, 0)

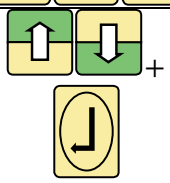


Setting procedure

1 **Select the Teach mode.**



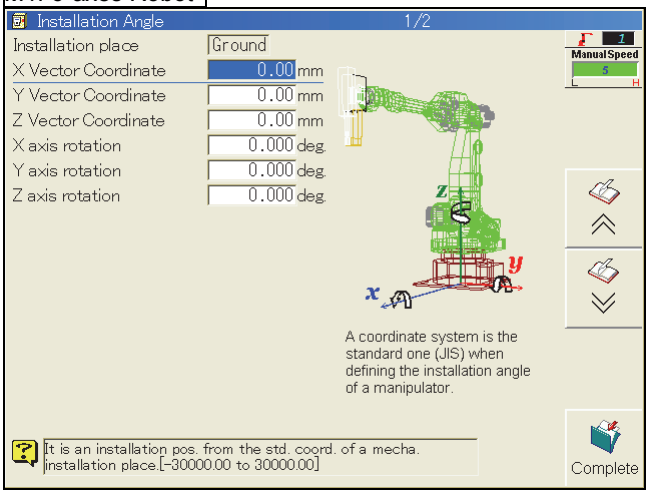
2 **Select the user level *EXPERT* or higher using the Shortcut code R314.**
(NOTE)
The initial password for the ***EXPERT*** level is not set. Just press [Enter] key.



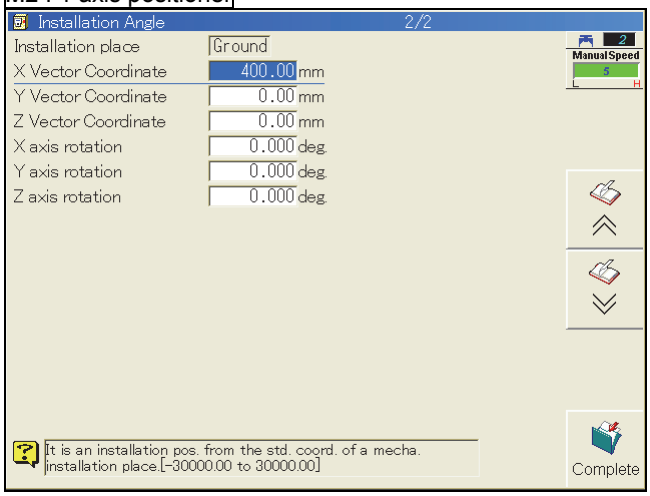
3 **Open <Constant Setting> [12 Format and Configuration] [5 Installation Angle].**

Set the parameters like this picture.

M1: 6-axes Robot



M2 : 1 axis positioner



4 **Press <Complete>.**
>>The setting is saved in the internal memory.

If the real installation coordinates of each mechanism and the setting coordinates of each mechanism in the robot controller are not the same, the accuracy of the position control may cause problems. To calibrate the installation position of each mechanism, refer to the following instruction manual.

"FD CONTROLLER INSTRUCTION MANUAL : CROSS MASTERING" (TFDEN-069)

7.3 Supplemental items

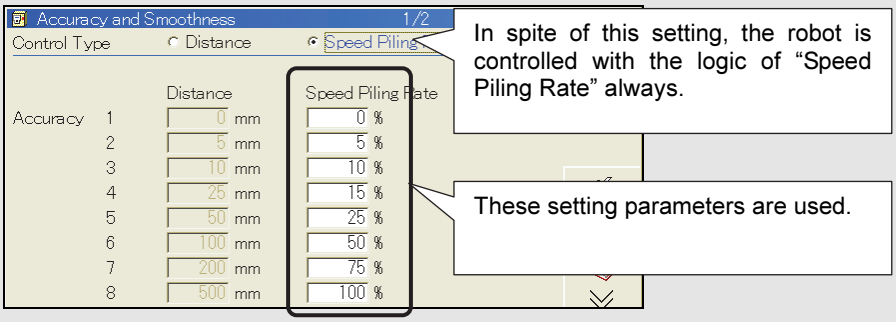
7.3.1 The “Distance based shortcut motion” and the “Speed Pilling Rate based shortcut motion”

“Speed Piling Rate based shortcut motion” is used always

If the synchro-motion function is enabled (-> “7.2.2 Enabling the Synchro-motion function”), the setting of the ***<Constant Setting> [4 Accuracy and Smoothness] “Control type”*** is ignored and the robot will be controlled with the logic of ***“Speed Piling Rate”*** always automatically.

And, for the ***“Speed Piling Rate”*** of each accuracy level (A1 – A8), the values in this setting screen is used.

POINT



Between the ***“Distance”*** setting and the ***“Speed Piling Rate”*** setting, the robot’s short-cut motion path are different each other. Be careful

“Speed Pilling Rate based short cut motion”

If the synchromotion function is enabled, this control is used always.

POINT

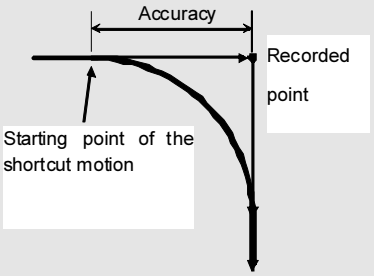
This is the speed-priority control system which draws the inside arc while combining the speeds of the axes before and after the recorded points. What is specified is not the distance but the combination rate in the form of the speed overlap ratio (%). The path changes in accordance with the recording speed (the higher the speed, the wider the inside arc), but the speeds are connected more smoothly than with the distance reference system.

"Distance based shortcut motion"

If the synchromotion function is enabled, this control is not used.

This is the path-priority control system which ensures that the command path will not change even if the recording speed is changed so that the robot's path will hardly change at all even if the playback speed is changed. It is set as the distance (in millimeters or inches) from the recorded point to the position where the inside arc starts.

POINT



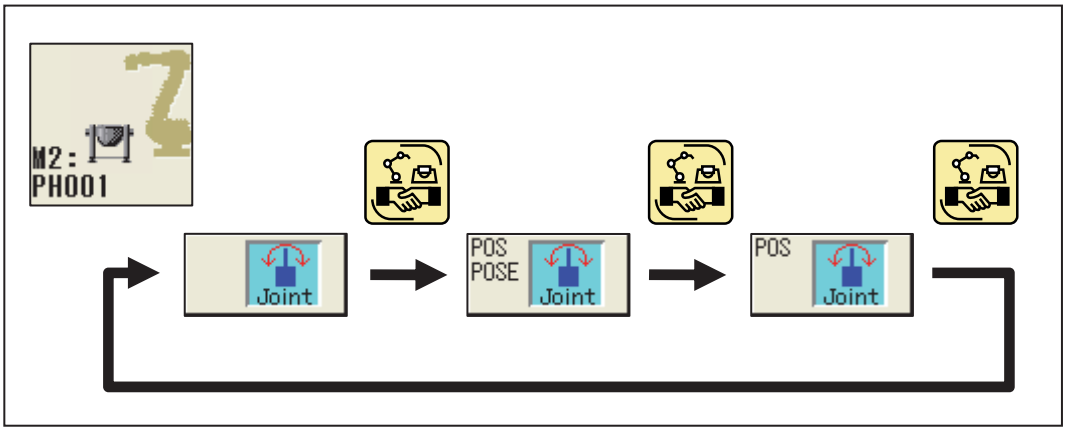
One-half of the distance between the recorded points is the maximum for this distance. If this distance is a short one, the path will follow the inside arc at the exact halfway point between the two.

7.3.2 Changing the operation mode of the Synchromotion (manual operation)

When operating the robot in the Teach mode, it is possible to select the following 3 modes using the [SYNCHRO] key.

(1) "Position and Posture synchromotion"
(2) "Position Synchromotion"
(3) "No-Synchromotion",

Refer to the *"7.1 Outline"* also.



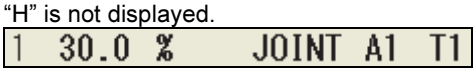
- Please be sure that this operation is available only while the master side mechanism is being selected. (In this example, "M2 : PH001")

- To select the mechanism, use the [MECHANISM] key.
  Every time this key is pressed, the current mechanism will change like M1, M2, M1, …

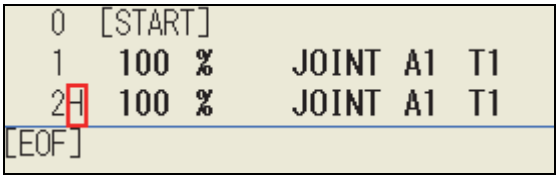
7.3.3 Simultaneous control and Synchronization control (Synchro-motion)

If the Synchro-motion function is enabled, the following 2 types of movement command can be used.
Please be sure that the motion path and the posture of the robot will change when “H” is set to ON or OFF.

(NOTE) In both cases, the shortcut motion is based on the “Spped Piling Rate” method.

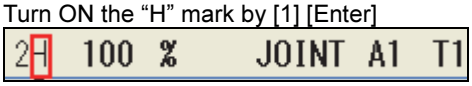
No.	Name	Motion	Display example
1	Simultaneous (No “H”)	**< No synchromotion>** This is the same with the normal motion. (The synchro-motion is not executed) Each mechanism moves independently.	“H” is not displayed. 
2	Synchro-motion (With “H”)	**<With synchromotion>** The synchro-motion is executed. All mechanisms will follow the motion of the Operation Standard Mechanism.	“H” is displayed. 

The “H” mark can be turned ON/OFF in the program edit screen. 

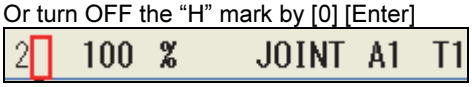


Set the cursor and …

Turn ON the “H” mark by [1] [Enter]



Or turn OFF the “H” mark by [0] [Enter]



7.3.4 What is the “Operation standard mechanism” ?

The ***“Operation standard mechanism”*** is the mechanism that is regarded as the position reference mechanism (Master mechanism) while executing the synchromotion. The other mechanisms (Slave mechanisms) in the same UNIT will be controlled by following the motion of the master mechanism.

See the following instruction manual also.
“FD CONTROLLER INSTRUCTION MANUAL : SYNCHROMOTION CONTROL” (TFDEN-024)

7.3.5 What is the “Speed standard mechanism” ?

The ***“Speed standard mechanism”*** is the mechanism that is regarded as the speed reference mechanism. When executing the Program Playback operation, the all other mechanism will move by referring to the motion speed of the Speed Standard mechanism.

For example, if the UNIT have a 6-axes robot (M1) and a 1 axis positioner (M2), and the robot is selected as the Speed Standard Mechanism, it is necessary to teach the motion speed of the robot. When playing back the teaching program, the positioner will synchronize with the motion speed of the robot (start with the robot and stop with the robot).

When the positioner is selected as the Speed Standard Mechanism, it is necessary to teach the motion speed of the positioner. When playing back the teaching program, the robot will synchronize with the motion speed of the positioner (start with the positioner and stop with the positioner).

In case of (robot + positioner), the robot should be set as the Speed Standard Mechanism.

See the following instruction manual also.
“FD CONTROLLER INSTRUCTION MANUAL : SYNCHROMOTION CONTROL” (TFDEN-024)

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Original manual is written in Japanese.