

NACHI

Robot school  
CFD standard course

*1st edition*

NACHI-FUJIKOSHI CORP.





**NACHI**  
Robot school

**CFD standard course**

**First time to use robot**

## Industrial robot history

### Diffusion of industrial robot

In 1960s, industrial robot was presented in the industrial news paper in USA. Diffused to industrial market.

### In Japan...

Imported from USA 1967, and quickly diffused in Japanese industrial market because

- Master dangerous task instead of worker
- Compensate the lack of worker
- Prevent from high wages in 1973 and 1979 oil shock
- Accelerated by the advanced control technology

## NACHI ROBOT history

1969	1980	1987	1994	1998	2001	2007	2011	2013
UNIMAN	8600 series	8608 series	SA series	SF series	SH series	ST-F series	SRA series	MZ series
Manufacture industrial robot	Electric industrial robot first in Japan	Concept: high production high reliability	Concept: Compact and save space	Concept: fast & fine	Concept: Module concept Easy maintenance	Concept: Built in application cable	Concept: High speed compact	Concept: High speed Smart cable layout
								
								
	CPU is used Programming thru CRT	Digital control Robot language Easy operation Color touch panel		Personal computer Open architecture				

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## What is “Industrial robot”

### Definition of “Industrial robot”

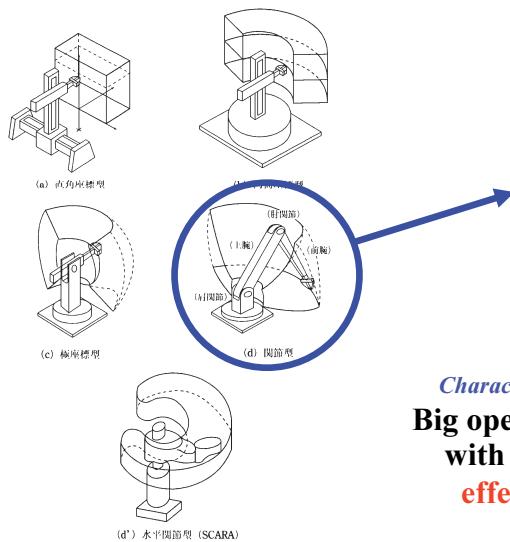


Machine with manipulating utility that is automatically controlled,  
enabling to re-programming and having more than 3 dimension freedom.

or

Having the similar movable utility with human being arm or hand, or  
having sensing ability or recognition ability.

## Articulated robot



*Characteristics of articulated robot*

**Big operating area compared  
with narrow small space  
effective usage of area**

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## How to read the type

**M Z 0 7 - 0 1 - C F D**

Robot (manipulator) series name



**MZ series**



**MC series**



**MR series**



**SRA series**

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## How to read the type

M Z 0 7 - 0 1 - C F D

Rated payload of robot  
unit : KG



Bigger size for heavier payload

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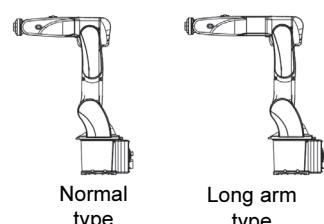
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## How to read the type

M Z 0 7 - 0 1 - C F D

**Robot supplement type**

L : long arm  
P : 5 axes arm  
LP : Long arm (5axes)



P (5 axes arm type) does  
not have the 4<sup>th</sup> axis.

Basically, **program is not compatible**.

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## How to read the type

M Z 0 7 - 0 1 - **C F D**

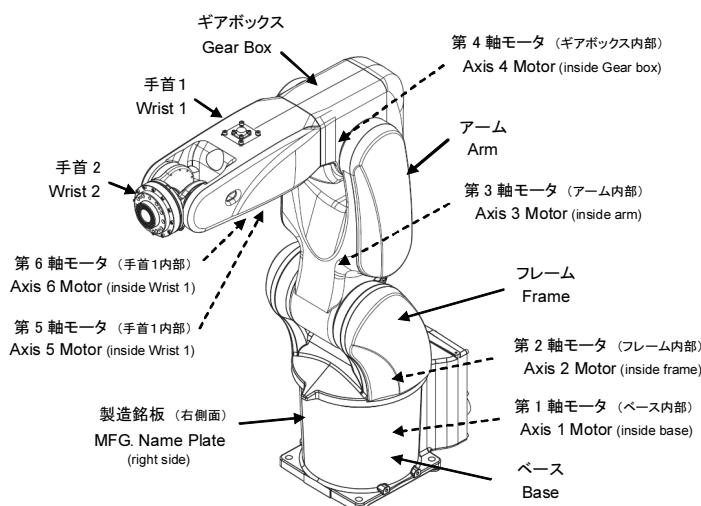
Controller series name

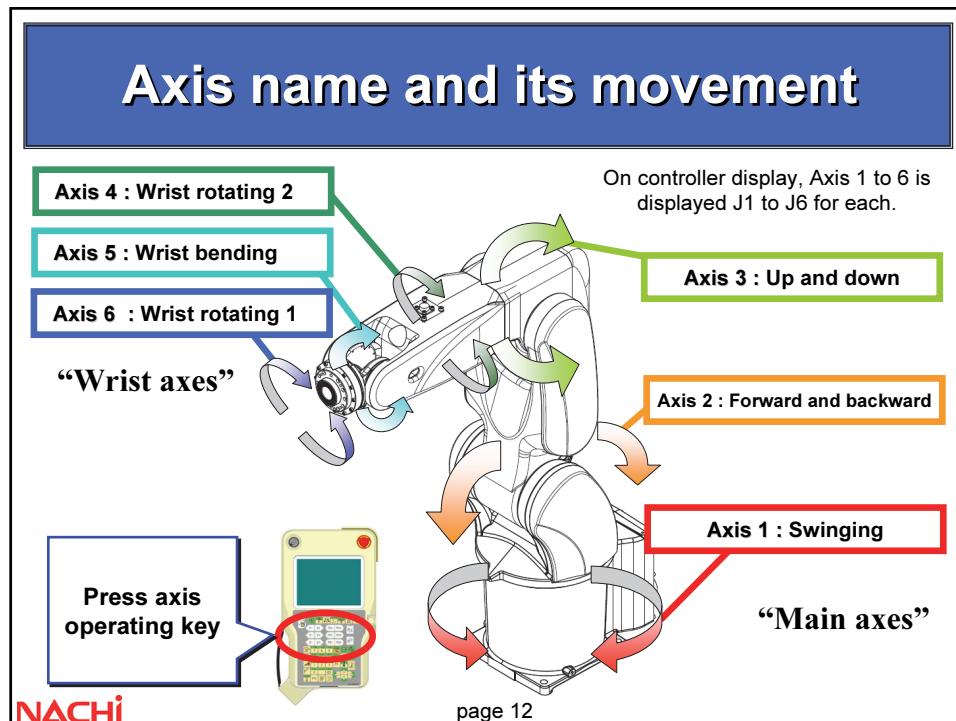
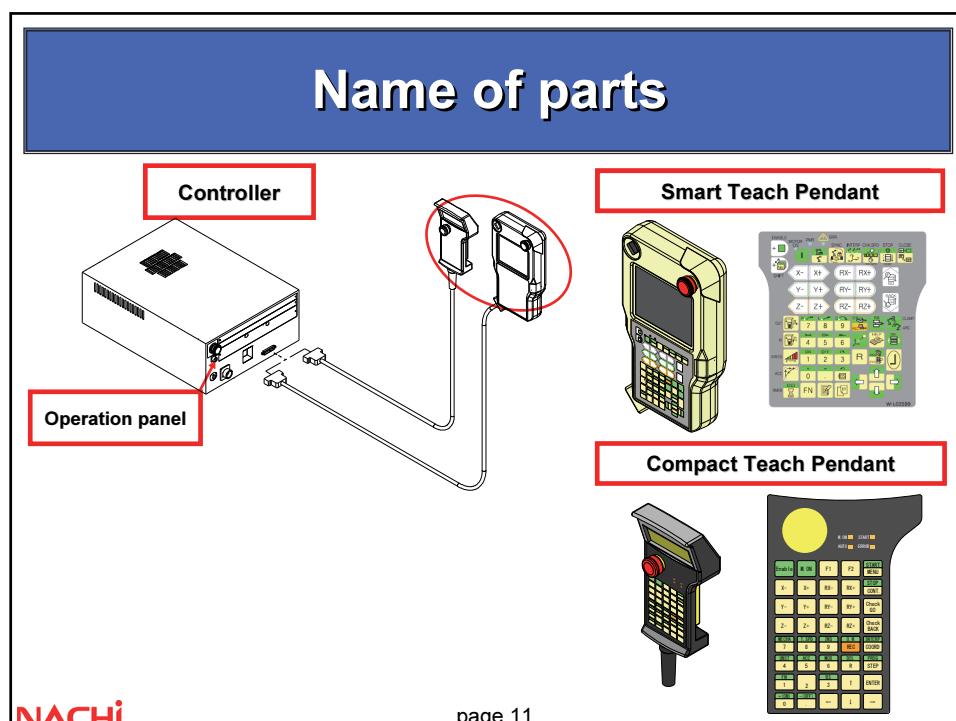


CFD CONTROLLER

CFD controller is a MZ series exclusive robot controller.

## Name of parts





## How to read basic specification

Item		Specification			
Robot type		MZ07-01	MZ07P-01	MZ07L-01	MZ07LP-01
Structure		Articulated			
Degree of Freedom		6	5	6	5
Actuator		AC servo motor			
Max. Operating range	Axis 1	$\pm 170^\circ$			
	Axis 2	$-135 \sim 80^\circ$			
	Axis 3	$-136 \sim 270^\circ$		$-139 \sim 270^\circ$	
	Axis 4	$\pm 190^\circ$	—	$\pm 190^\circ$	—
	Axis 5	$\pm 120^\circ$			
	Axis 6	$\pm 360^\circ$			
Max. Speed	Axis 1	$450^\circ/\text{s}$		$300^\circ/\text{s}$	
	Axis 2	$380^\circ/\text{s}$		$280^\circ/\text{s}$	
	Axis 3	$520^\circ/\text{s}$		$360^\circ/\text{s}$	
	Axis 4	$550^\circ/\text{s}$	—	$550^\circ/\text{s}$	—
	Axis 5	$550^\circ/\text{s}$			
	Axis 6	$1000^\circ/\text{s}$			

Number of joint (axis)  
Normally "6"

How wide space  
robot can move

How short time  
robot can finish work

- $3.14[\text{rad}] = 180^\circ$ ,  $1[\text{N}\cdot\text{m}] = 1/9.8[\text{kgf}\cdot\text{m}]$
- On controller display, axis 1 to axis 6 is displayed J1 to J6 for each.

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## How to read basic specification

Item		Specification						
Robot type		MZ07-01	MZ07P-01	MZ07L-01	MZ07LP-01			
Payload	Wrist	7 kg						
Allowable static torque	Axis 4	16.6 N·m	—	16.6 N·m	—			
	Axis 5	16.6 N·m						
	Axis 6	9.4 N·m						
Payload inertia	Axis 4	0.47 kg·m <sup>2</sup>	—	0.47 kg·m <sup>2</sup>	—			
	Axis 5	0.47 kg·m <sup>2</sup>						
	Axis 6	0.15 kg·m <sup>2</sup>						
Repeatability		$\pm 0.02\text{mm}$	$\pm 0.03\text{mm}$					
Max. reach		723mm	912mm					
Air		$\phi 6 \times 2$						
Application signals		10						
Installation		Floor / Wall / Angle / Ceiling mount						
Ambient condition		Temperature: $0 \sim 45^\circ\text{C}$ Humidity: $20 \sim 85\%$ RH (No dew allowed) Vibration to swivel base: not larger than 0.5 G (4.9m/s <sup>2</sup> )						
Environment		IP67相当 (防塵・防滴)						
Mass		30kg	32kg					

How heavy payload  
robot can carry

How accurate  
robot can perform

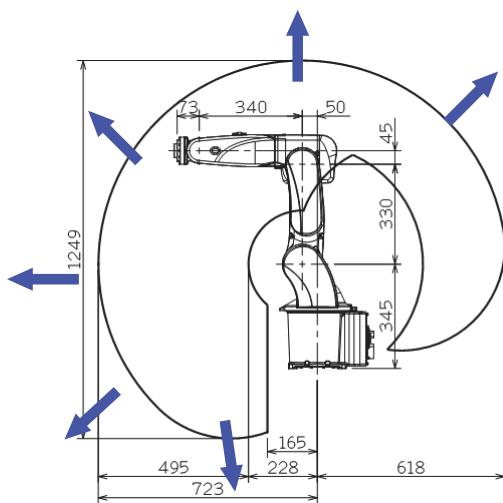
Where to be used

- $3.14[\text{rad}] = 180^\circ$ ,  $1[\text{N}\cdot\text{m}] = 1/9.8[\text{kgf}\cdot\text{m}]$
- On controller display, axis 1 to axis 6 is displayed J1 to J6 for each.

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## Operating range



When tool is attached,  
this range becomes wider.

Operating range written in  
basic specification sheet  
indicates the locus of  
this position called "point A".

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### CFD standard course

#### Operation

- Section#1: Operating Panel and Teach Pendant
- Section#2: Power ON and Mode selection
- Section#3: Motor power ON and Manual operation
- Section#4: Teach
- Section#5: Various operations for Teach
- Section#6: Playback

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## Section#1 Operating Panel Teach Pendant

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### Teach and Playback

**Teach** 

**Playback** 

**“Teach”** (teaching) is programming (recording) the task to robot. Move command, signal ON/OFF, call, jump and welding command are recorded in program.

**“Playback”** (playing) is executing the recorded program automatically. Robot does its task according to the recorded program.

Program sample

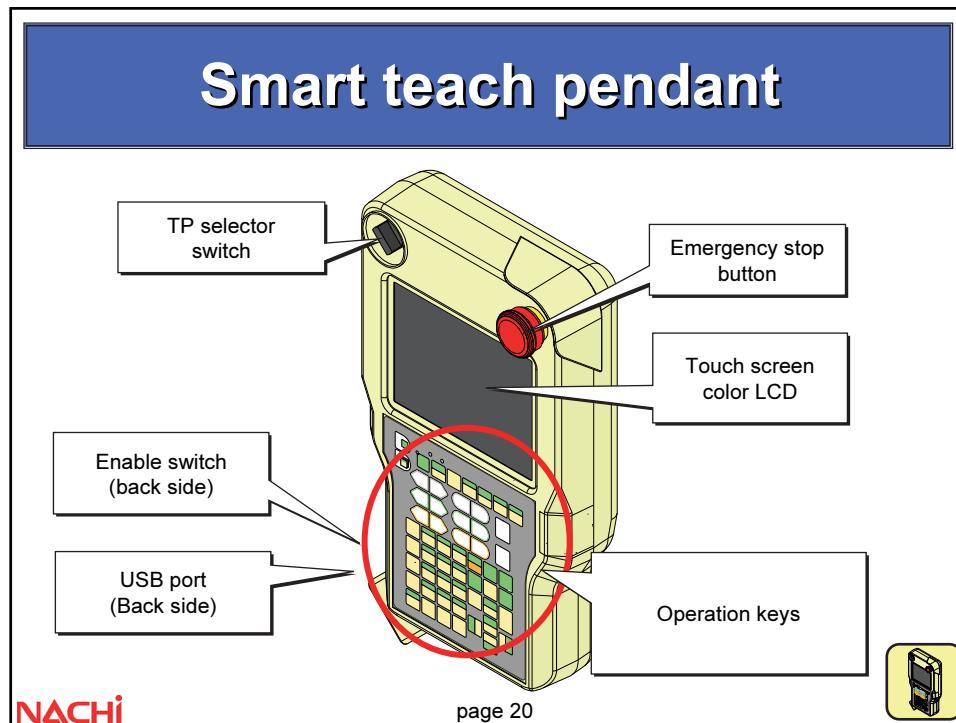
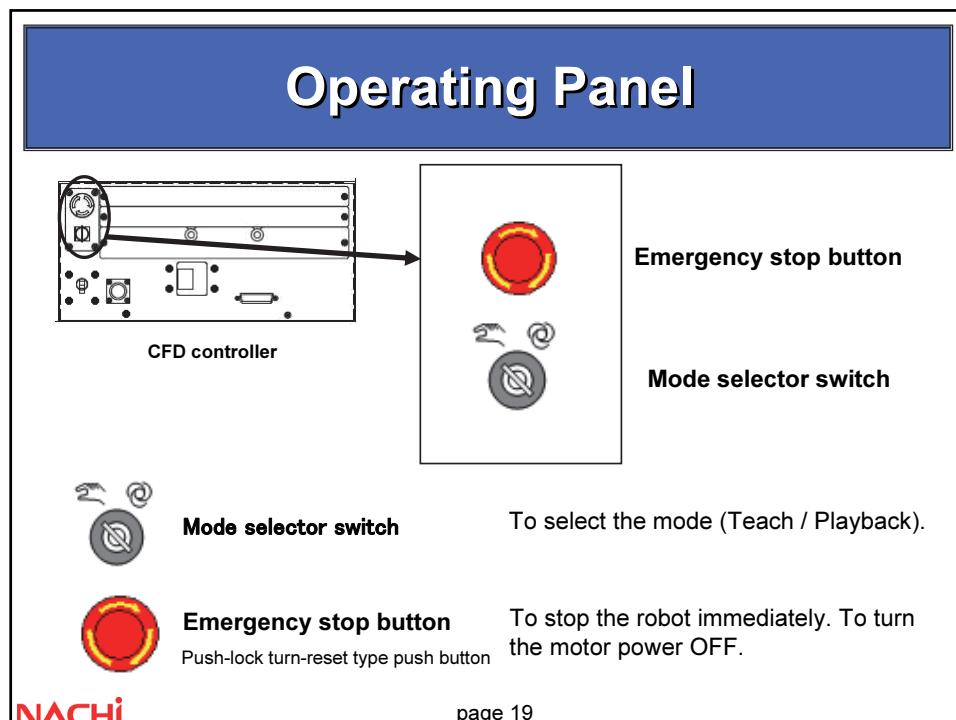
```
0 [STAR]
1 REM["Test-Program"]      F009;Comment
2 ALLCLR
3 100 z JOINT A1 T1      F010;Output signal all
4 100 z JOINT A1 T1
5 100 z JOINT A1 T1
6 100 z JOINT A1 T1
7 100 z JOINT A1 T1
[EOF]
```

Program playback

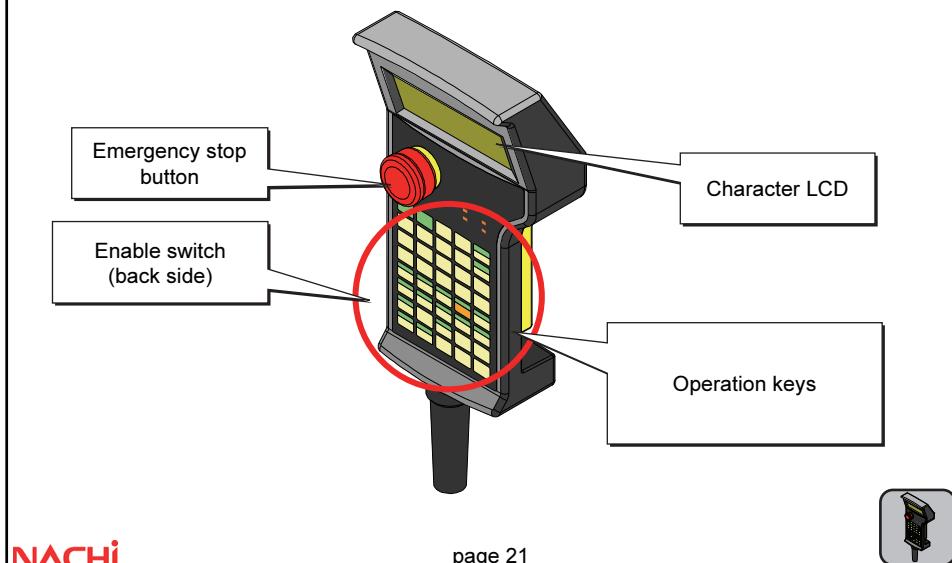


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## Compact teach pendant

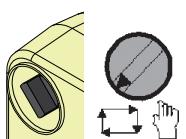


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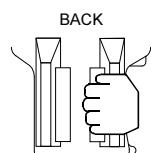
## Smart teach pendant



**“TP selector switch”** for safety operation  
This determines the operating mode with the combination of “Mode selector switch” of operating panel.



**“Emergency stop button”**  
Robot stops immediately and motor power OFF.



**“Enable switch”**  
Grip this switch in left hand to operate the robot. When not operating, release this switch.  
**In emergency, just release or compress this switch to stop the robot immediately.**  
This switch is not used in playback mode.



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## Smart teach pendant

To enable green colored keys, press this key at the same time

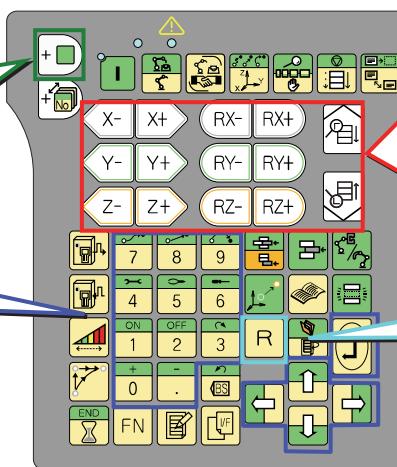
- (1) Avoid miss-operation
- (2) Second function in one key

### To input parameters

Select menu by [cursor] key

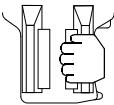
↓ Input number by [ten key]

↓ Finish by [Enter] key



### Keys to move the robot

Operate these keys while gripping the enable SW and watching robot carefully



Due to the applications, [Clamp/Arc] key can also move gun and gripper.

### To cancel input operation

This can designate the shortcut operation at the top screen.



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## Compact teach pendant

To enable green colored keys, press this key at the same time

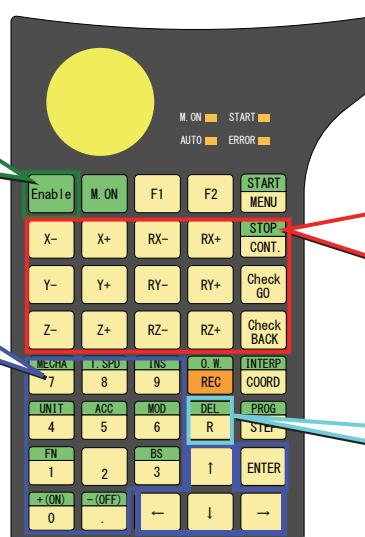
- (1) Avoid miss-operation
- (2) Second function in one key

### To input parameters

Select menu by [cursor] key

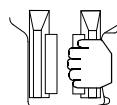
↓ Input number by [ten key]

↓ Finish by [Enter] key



### Keys to move the robot

Operate these keys while gripping the enable SW and watching robot carefully



Due to the applications, [Clamp/Arc] key can also move gun and gripper.

### To cancel input operation

This can designate the shortcut operation at the top screen.



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**Section#2**

## Controller power ON

### Mode selection

*SEE ALSO:*

TCFEN-154  
CFD / START UP

TFDEN-002  
FD / BASIC OPERATIONS MANUAL

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## Controller power ON

1. Turn the controller main power ON.

Main power switch

2. After self check completed, starting screen comes up as followed.

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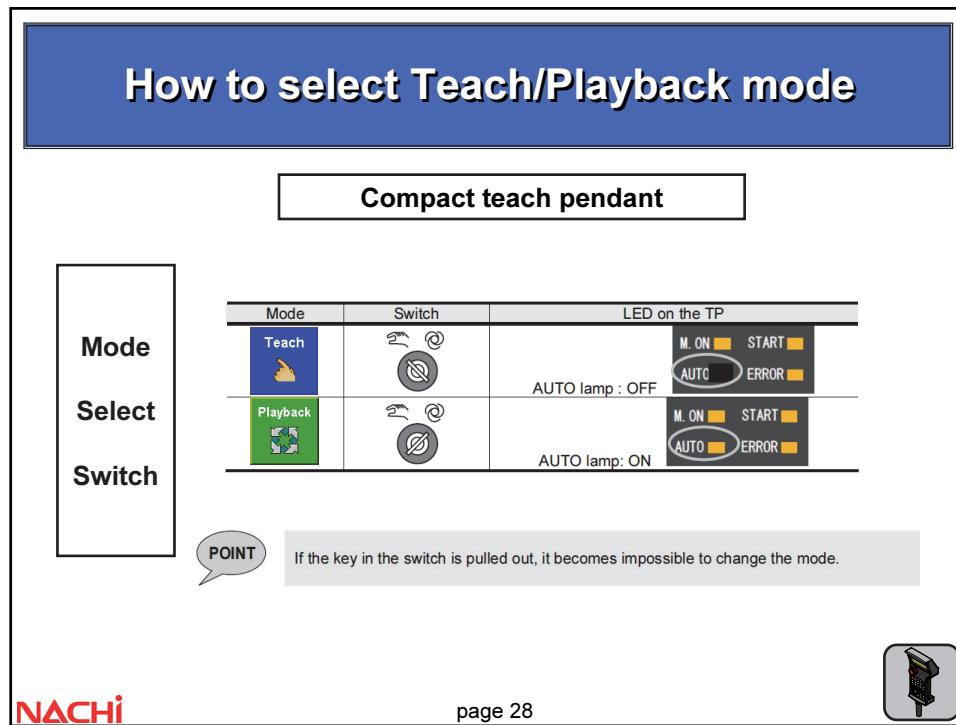
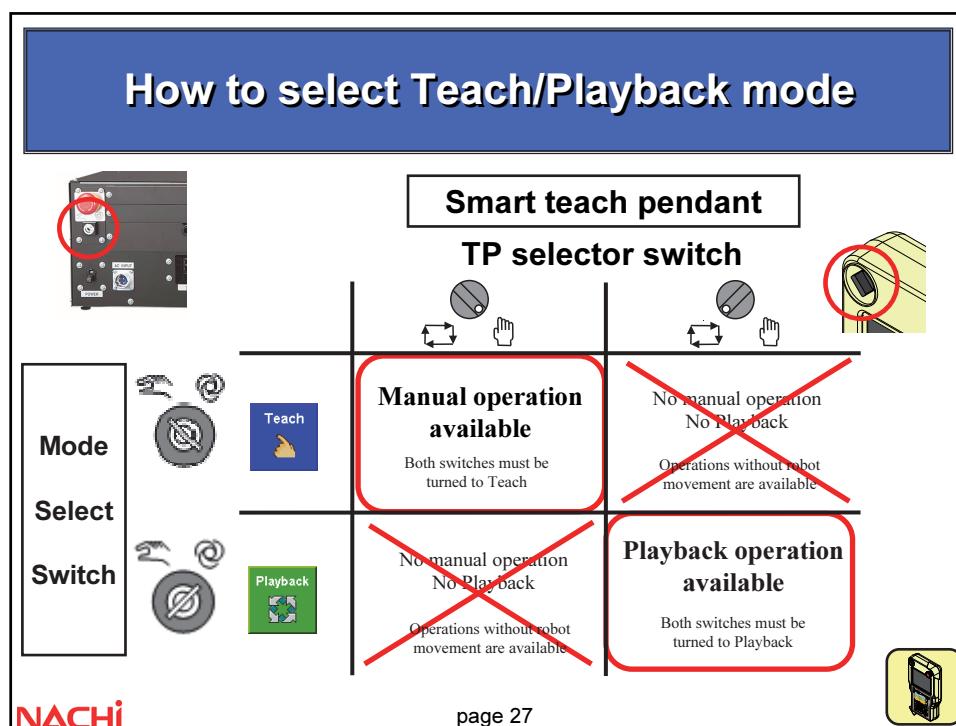
Smart teach pendant

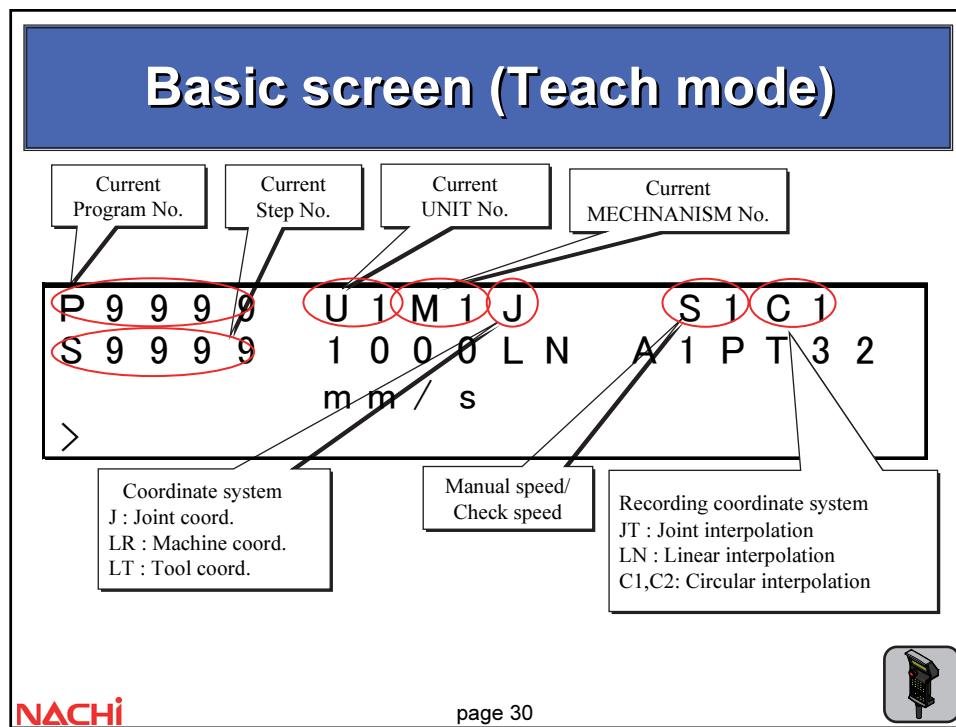
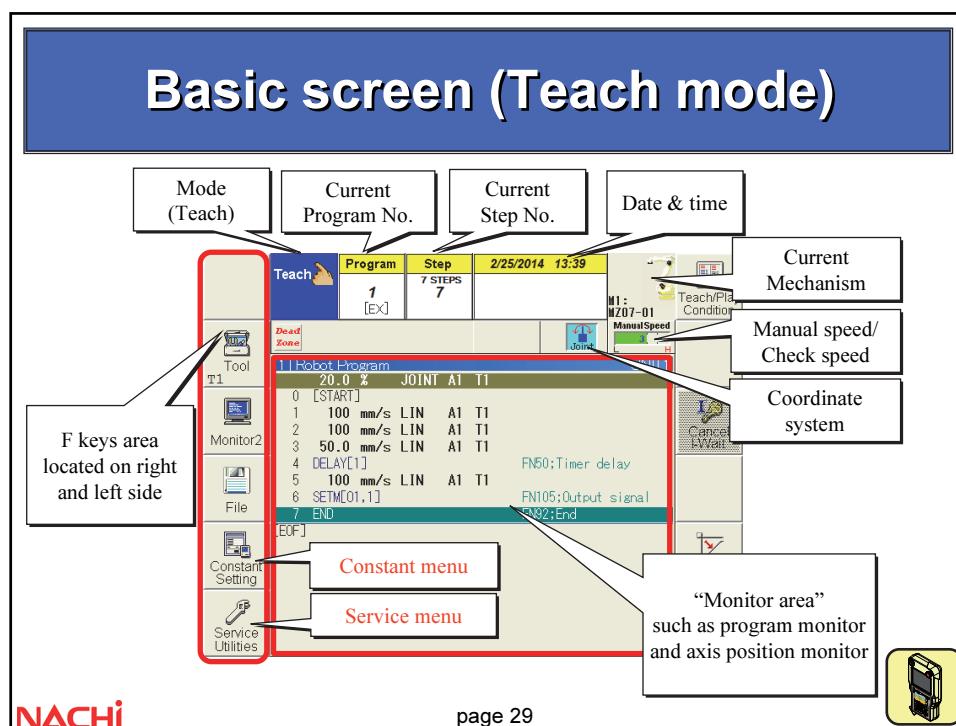
Compact teach pendant

Starting screen is determined by the mode selector switch.

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## F key changes due to application

F keys are already allocated at the shipment for the best operation according to its application.  
Also, allocation is free to change.

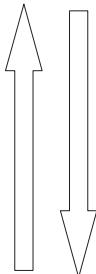
Standard F keys



## Switching the “Operator class”

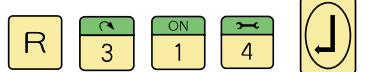
If same operation is done, you will go down to **USER** again.

**USER**



**EXPERT**

On the top screen in Teach or Playback



\* Password setting

The operator under use is “USER” now.  
Please enter the password.  
The soft-keyboard can be used by pushing “Enable + edit”.



**EXPERT** password of shipment is defined  
“none”. So just press ENTER key is enough  
to going up to **EXPERT**.



The operator has been set to “EXPERT”.  
Please push any key to continue.

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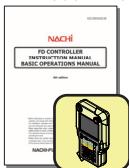
### SEE ALSO:

TCFEN-154  
CFD / START UP



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TFDEN-002  
FD / BASIC OPERATIONS MANUAL



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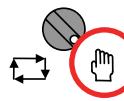
## Motor Power ON



Select TEACH by the “mode selector switch” on operating panel. And pull out the key and keep it.



TEACH mode icon is displayed on left top.



Select TEACH side of “TP selector switch” on teach pendant. (Smart teach pendant)



Now manual operation is permitted.



Smart teach pendant



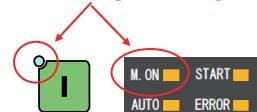
Press the [Enable] + [Motors ON] at the same time.



Now ready to turn the motor power ON. But real motor power is still OFF. Motor On lamp is flashing.



Compact teach pendant

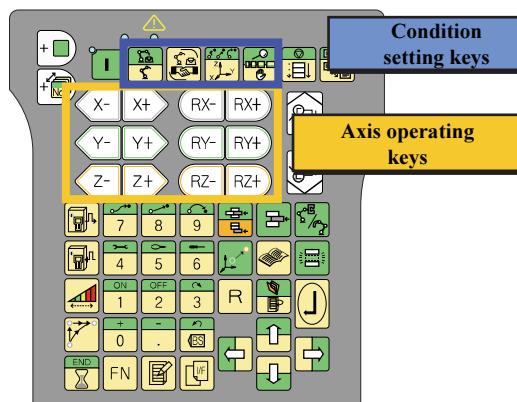


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## Manual operation

Smart teach pendant



Compact teach pendant

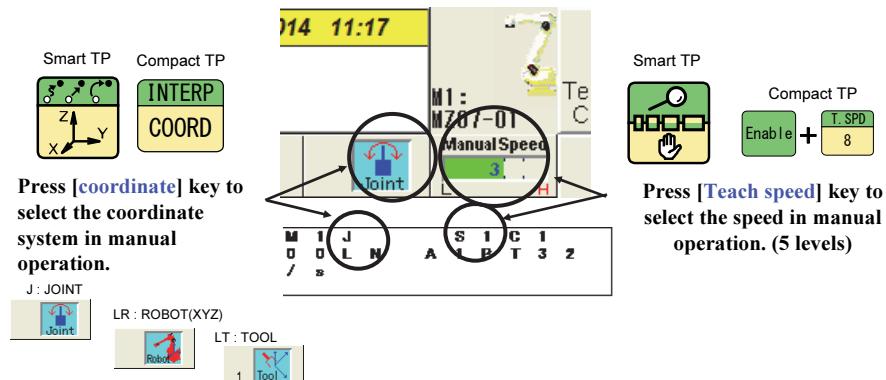


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## Select coordinate system and manual speed

Before moving the robot, [coordinate] and [speed] must be selected.



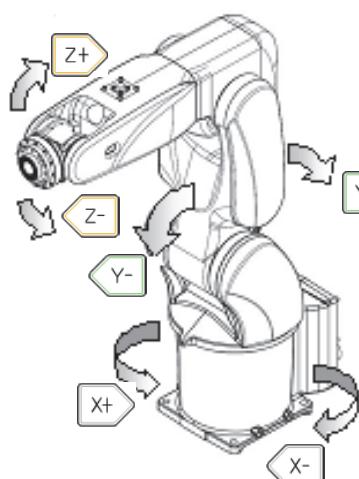
Beginner operators had better do practice to see the robot movement by the coordinate system and speed.

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## Joint manual operation (1)



Press [X+-] to rotate axis 1 (swing base).

Press [Y+-] to rotate axis 2 (2nd arm).

Press [Z+-] to rotate axis 3 (1st arm).

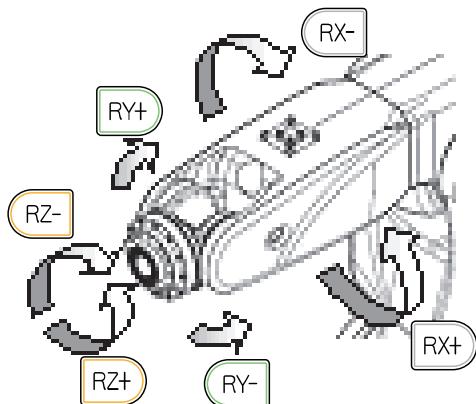
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## Joint manual operation (2)



Press [RX+/-] to rotate axis 4  
(1st axis of wrist).

Press [RY+/-] to rotate axis 5  
(2nd axis of wrist).

Press [RZ+/-] to rotate axis 6  
(3rd axis of wrist).

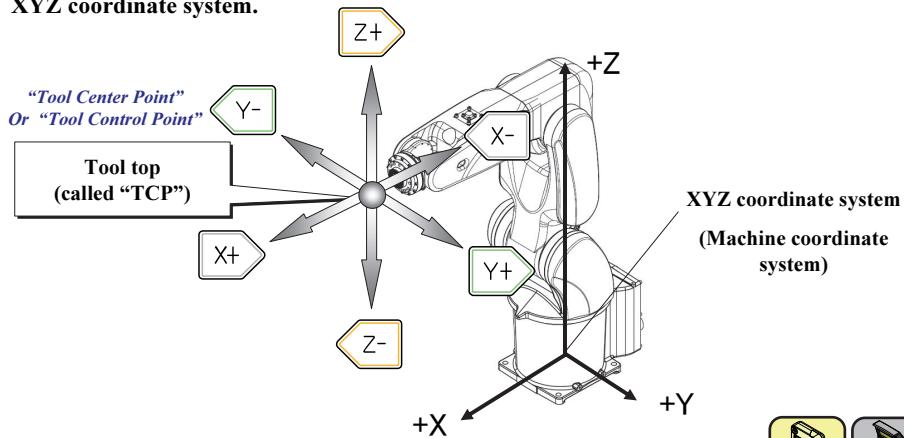
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## XYZ manual operation (1)

XYZ coordinate system (Machine coordinate system / Robot coordinate system) is fixed on the robot base. When pressing main axes key, TCP moves parallel along this XYZ coordinate system.



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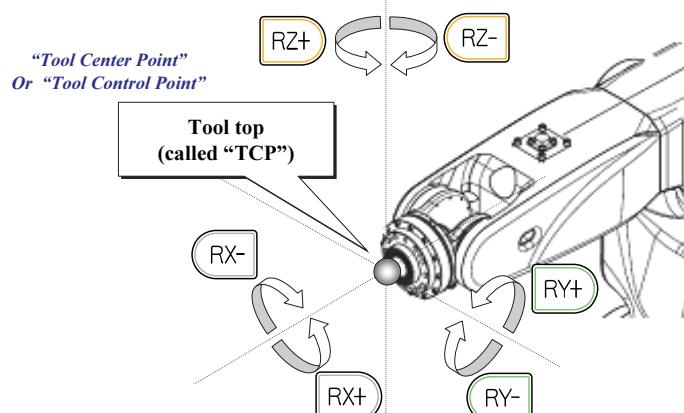
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## XYZ manual operation (2)

When pressing wrist axes key (RX, RY and RZ), robot twists its tool while keeping TCP position stationary. Rotating direction is based on the XYZ coordinate system. This is convenient to change wrist attitude after fixing TCP position.



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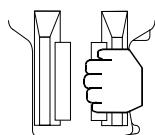


## Let's move the robot

Now let's move the robot. Pay utmost attention.



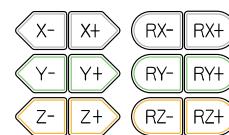
*Place your hand on the emergency push button while moving the robot. Always operator has to be in ready position to press emergency stop button.*



Grip enable switch. Motor power is turned ON.  
In emergency, just release or compress this switch to turn motor power OFF.



Motor power lamp is turned ON.



Press axis operating key to move robot.



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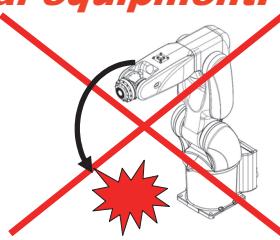
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## Caution in operating robot

Every time pay utmost attention to the robot destination space.

Also tool and cables on the robot arm must be cared.

***Every time pay utmost attention while operating the robot to protect not only yourself but also the robot, work piece and peripheral equipment.***



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## Caution in operating robot

Releasing enable switch can stop the robot immediately, but careless operation causes unnecessary brake pad consumption.



**Normally release the axis operating key to stop the robot.**

After that, release enable switch.

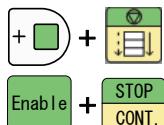


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## When not operating the robot

When not operating the robot, turn the motor power OFF for safety.



While playback, press [Enable]+[STOP] to stop the robot.

While manual operation, just release the axis operating key.



After confirming robot stops, press emergency stop button.

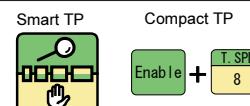


Motor power is turned OFF.

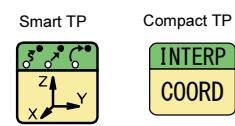


## Practice

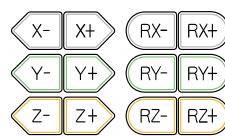
1. Confirm the real robot speed by changing the manual speed level 1 to 5.



2. Confirm the real robot movement by changing the coordinate system.



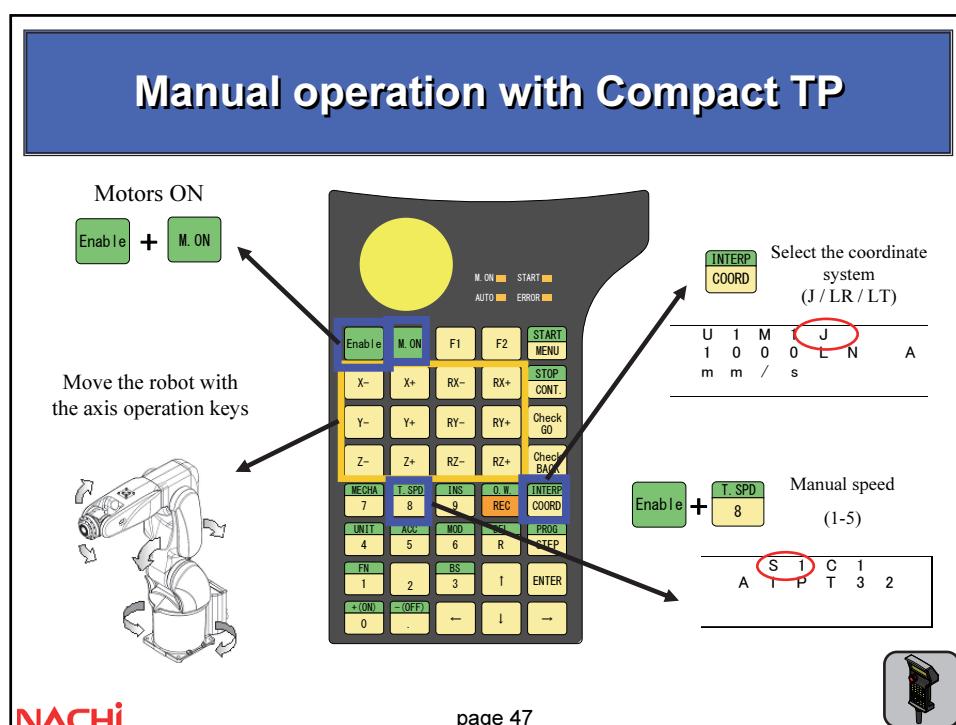
3. Confirm the real robot movement (fixing TCP movement) when pressing RX, RY and RZ key in [XYZ] mode.



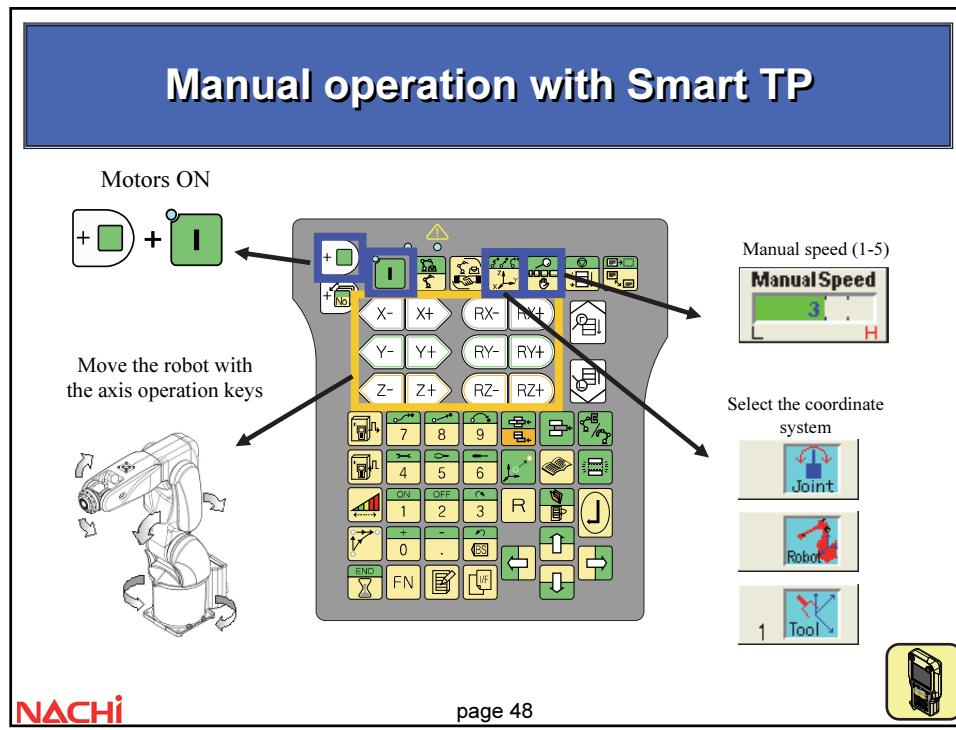
4. Put the tool attitude in slant position, and confirm the real robot movement when pressing [Tool] mode. Confirm the difference from [XYZ] mode.



## Manual operation with Compact TP



## Manual operation with Smart TP



**Section#4**  
**Teach**

**SEE ALSO:**

- TCFEN-154  
CFD / START UP
- TFDEN-002  
FD / BASIC OPERATIONS MANUAL

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### Top screen of Teach mode (Smart teach pendant)

Current mode. Confirm “Teach” is displayed.

Current program No. When empty, [none] is displayed.

Current step No.

Comment of current program. (If recorded)

Recording status.  
This indicates the information those are recorded in next step.

Teach

Program	Step	2/25/2014 13:39
1	7 STEPS	
[Ex]		

Dead Zone

M1 : M207-01

Manual Speed

Joint

INIT1

Robot Program

20.0 X JOINT A1 T1

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## Top screen of Teach mode (Compact teach pendant)

**Current mode.** Confirm "AUTO" lamp is OFF.

**Current program No.** When empty, [none] is displayed.

**Current step No.**



P 9 9 9 9	U 1 M 1 J	S 1 L N	A 1 P T 3 2
S 0 0 0 1	1 0 0 0 L N		
	m m / s		

&gt;

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## Program construction

### Program

0 to 9999



[P 0 0 0 0 1]  
[S 0 0 0 0 2]  
>

Select the desired number, and record steps in it.

### Step (command)

0 to 9999



[P 0 0 0 0 1]  
[S 0 0 0 0 2]  
>

Move command can move the robot. And function command can execute variable things.

### Move command

Move the robot to the recorded position.

(sample) 100 mm/s LIN A1 T1

### Function command

This can execute signal ON/OFF, call other program, delay, welding and or so.

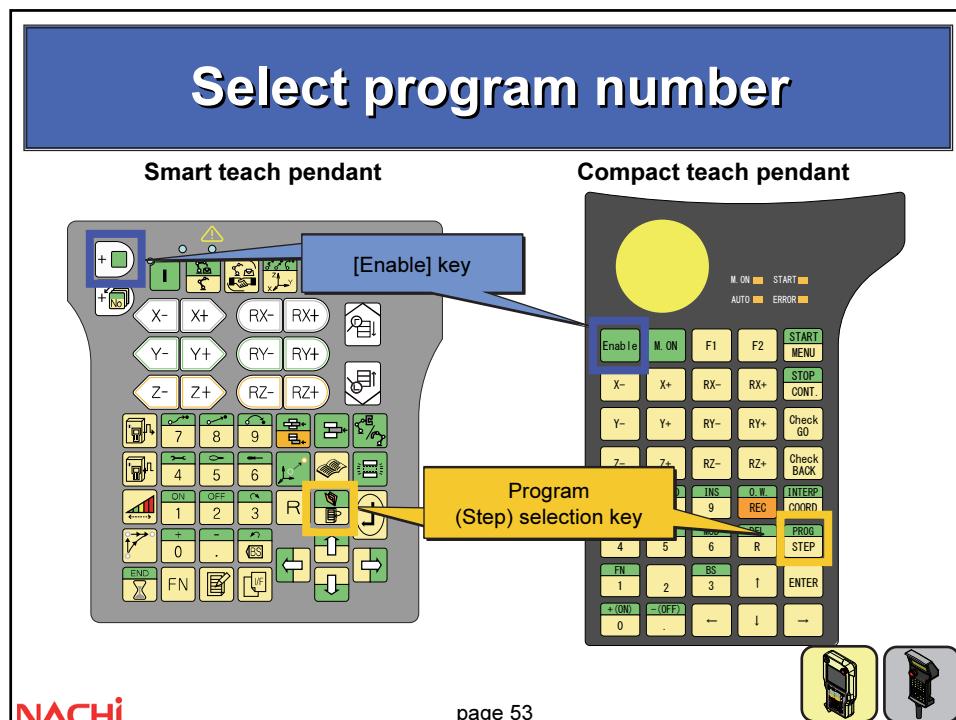
#### (Sample)

END	FN92 ; End
SPOT	FN119 ; Spot welding
CALLP	FN80 ; Program Call
DELAY	FN50 ; Delay
SETM	FN105 ; Signal ON/OFF

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## Select program number

Current (=selected) program content is displayed on the screen. How to change current program, please operate as followed.

- Press [PROG/STEP] key while pressing [ENABLE] key.

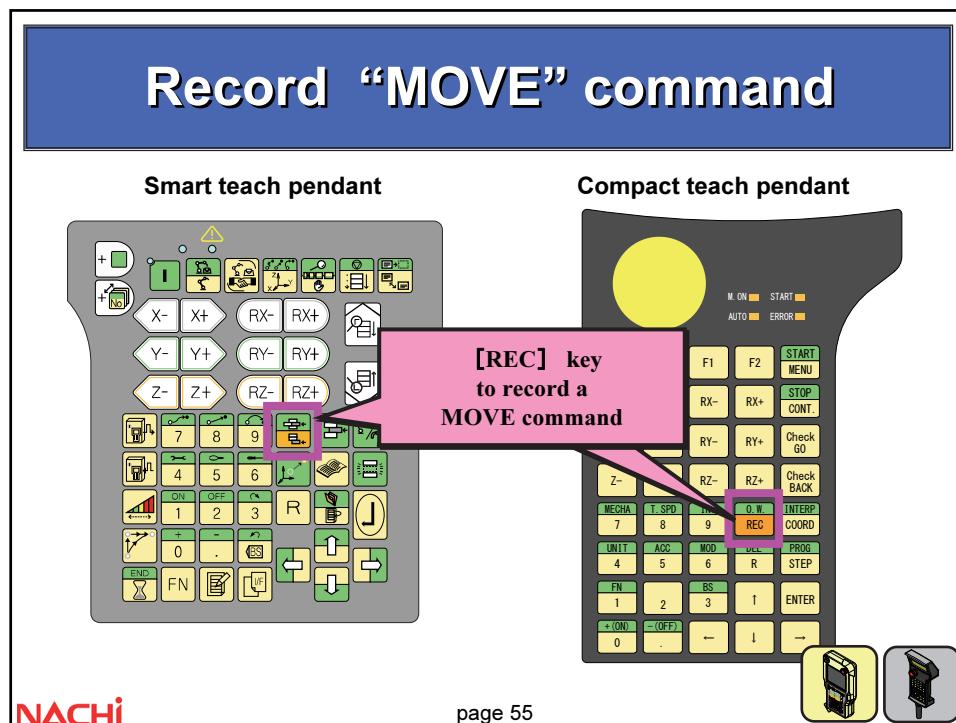
Smart TP 	Compact TP 	[ENABLE] key enables the green colored function. So it is "PROGRAM".
--------------	----------------	--

[ENABLE] + [PROG/STEP]

- Following dialog is displayed, then key in the requested program number (0 to 9999) and finally press [ENTER]. Requested program content is loaded and screen is refreshed.

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## Record “MOVE” command (Smart teach pendant)

Command to move robot is called “MOVE” command.  
One line (one step) has one destination position.

Step No.	Tool No.	Acceleration and smoothness
2	100 %	JOINT A1 T1 D53
3	100 %	JOINT A1 T1
4	1200 mm/s	LIN A1 T1

Comment

Speed Interpolation Accuracy Continue / Pause

Come Here By this way

Move the robot to the desired position and press [REC].

Smart teach pendant

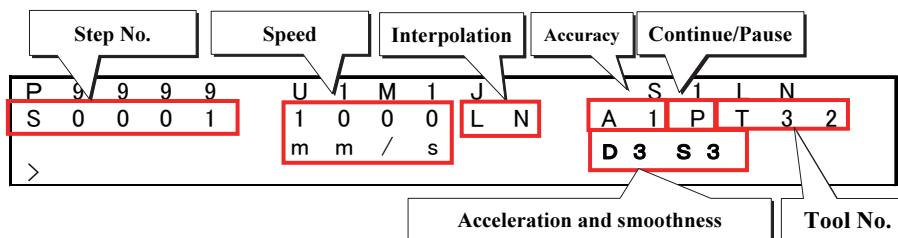
3 100 % JOINT A1 T1

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## Record “MOVE” command (Compact teach pendant)

Command to move robot is called “MOVE” command.  
One line (one step) has one destination position.



Move the robot to the desired position and press [REC].

Compact teach pendant



P 9 9 9 9	U 1 M 1 J	S 1 L N	A 1 P T 3 2
S 0 0 0 1	1 0 0 0	m m / s	
>			

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## Speed dimension

How to designate the robot speed?

- mm/s** : Designating by the line speed of TCP.
- %** : Designating by the robot ability ratio.
- sec** : Designating by the time to reach.
- deg/s** : Designating by the tool changing speed.

By utilizing “Screen editor”, speed dimension is free to be changed after recoding step. (Screen editor is available only in the Smart teach pendant or the FD on Desk)

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## Interpolation

How to designate the trajectory of robot?

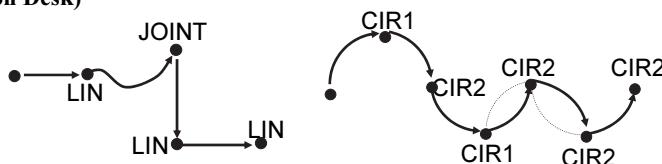
**LIN** : TCP trajectory is **linear**.

**JOINT**: TCP trajectory is **never linear**. (each axis is driven separately.)

**CIR1** : TCP trajectory is circle. (mid point)

**CIR2** : TCP trajectory is circle. (final point)

By utilizing “**Screen editor**”, interpolation designation is free to be changed after recording step. (Screen editor is available only in the Smart teach pendant or the FD on Desk)

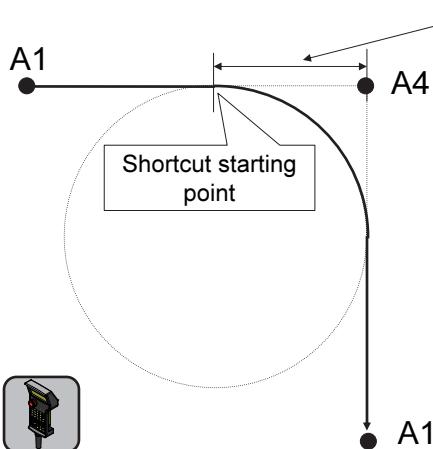


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## Accuracy

“Accuracy” is designating the shortcut level when passing through the recorded point. Bigger number makes bigger shortcut (away from the recorded point).



Factory setting [mm]
A1 0
A2 5
A3 10
A4 25
A5 50
A6 100
A7 200
A8 500

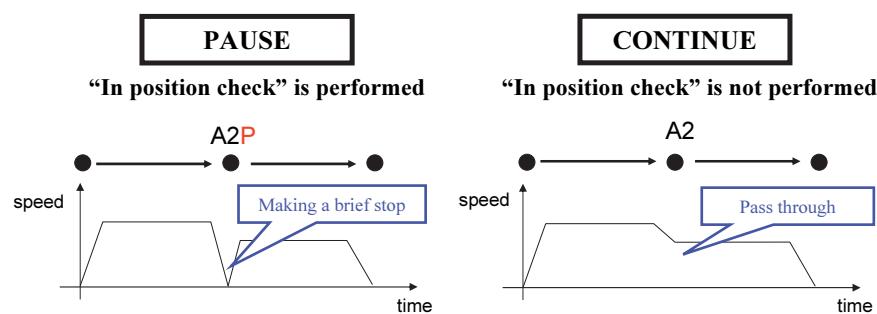
Shortcut level for each accuracy is set in Constant menu. The distance between shortcut starting point and recorded point is registered.



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## Continue / Pause



• "PAUSE" means that software once stops at the recorded position irrelevant to the accuracy level and waits for the robot arrival within the accuracy level (This is called "in position check"). "CONTINUE" means that software does not reach to the recorded position and follow the shortcut trajectory according to the accuracy level.

• "In position check" is automatically performed on the function step such as spot welding, because these command originally needs high accuracy. "P" mark is unnecessary.

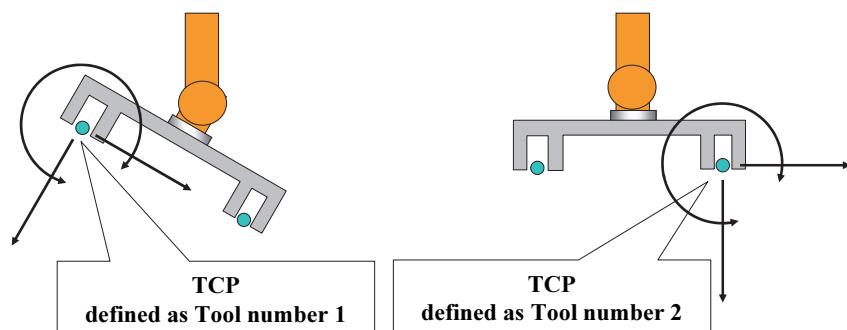
NACHI

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## Tool number

This number is designating the tool number (T1 to 32) to select which tool (which TCP) is mounted on the robot.



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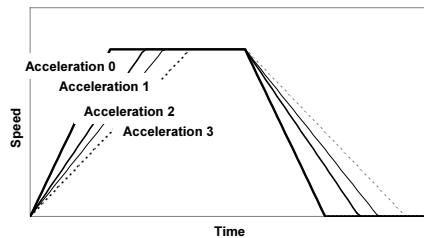


## Acceleration and smoothness

If tool or work-piece has vibration because of their low stiffness, this command can move the robot smoothly.

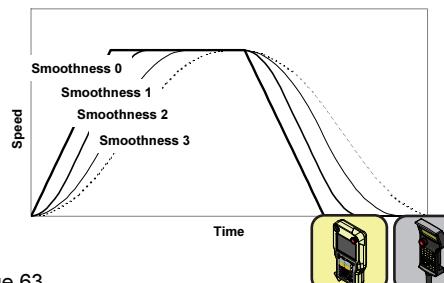
### Acceleration

Soft motion can be adjusted by acceleration, designated by 4 degrees of 0 to 3. 0 is not displayed and has maximum acceleration.



### Smoothness

Soft motion can be adjusted by acceleration speed, designated by 4 degrees of 0 to 3. 0 is not displayed and has maximum acceleration speed.

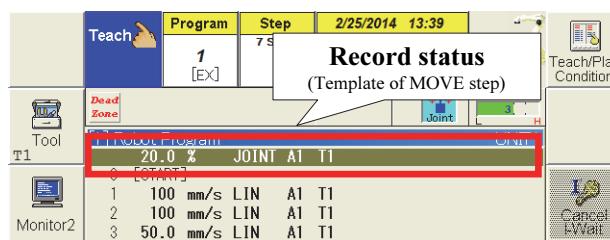


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## Record status (Template of move step)

Move step can be recorded after preparing the conditions such as speed and interpolation. To do so, define the “Record status” displayed at the top line of monitor area to the desired condition and press [REC] key.



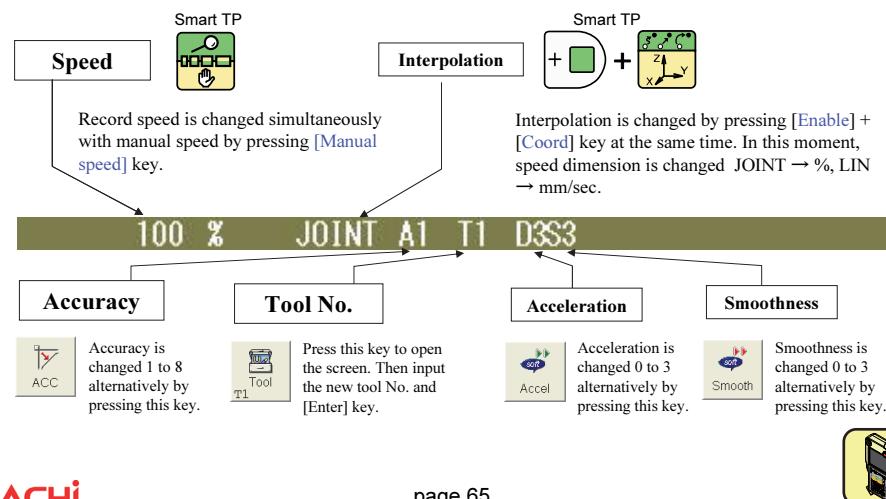
After recording MOVE steps, these condition can be easily modified by “Screen editor”. Do not consider “record status” seriously. (Screen editor is available only in the Smart teach pendant or the FD on Desk)

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## Record status (Smart teach pendant)

### How to set “Record status”



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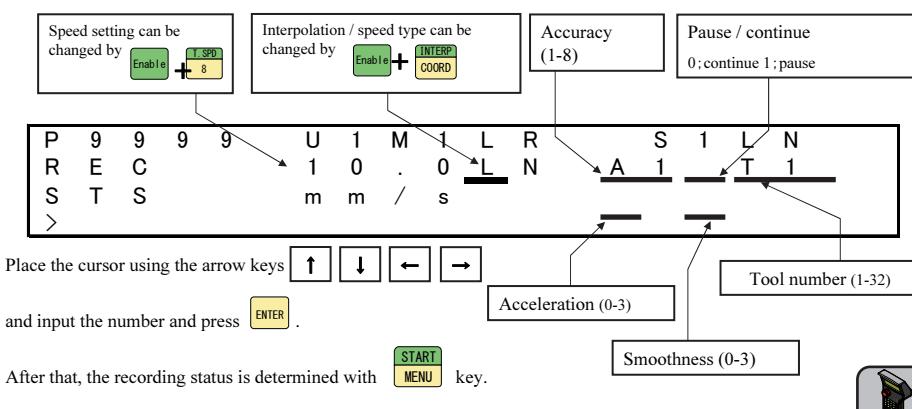
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## Record status (Compact teach pendant)

### How to set “Recording status”

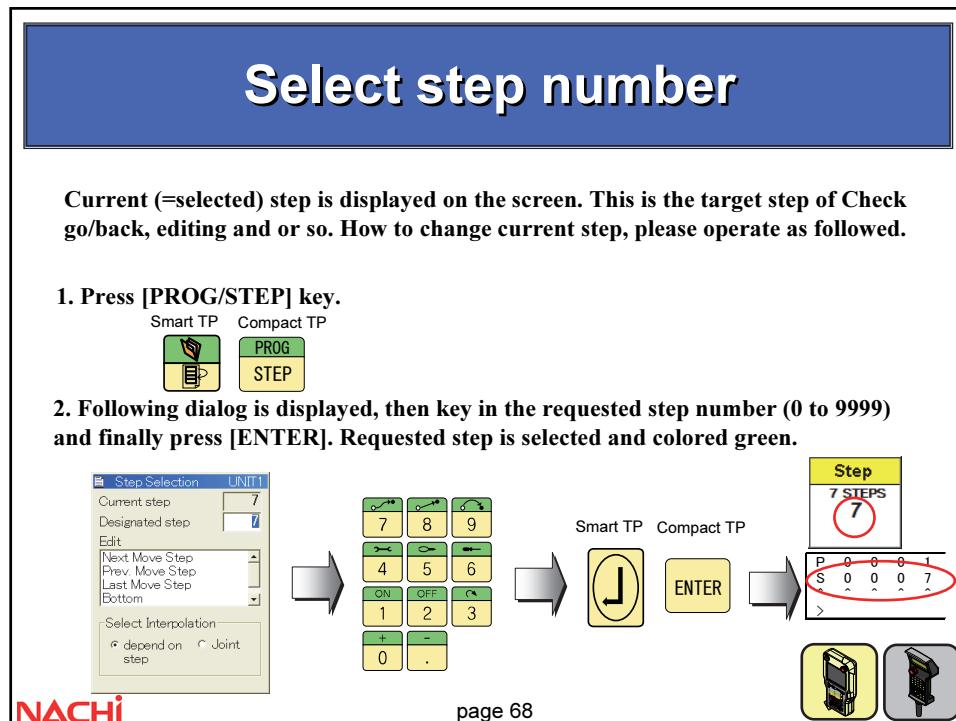
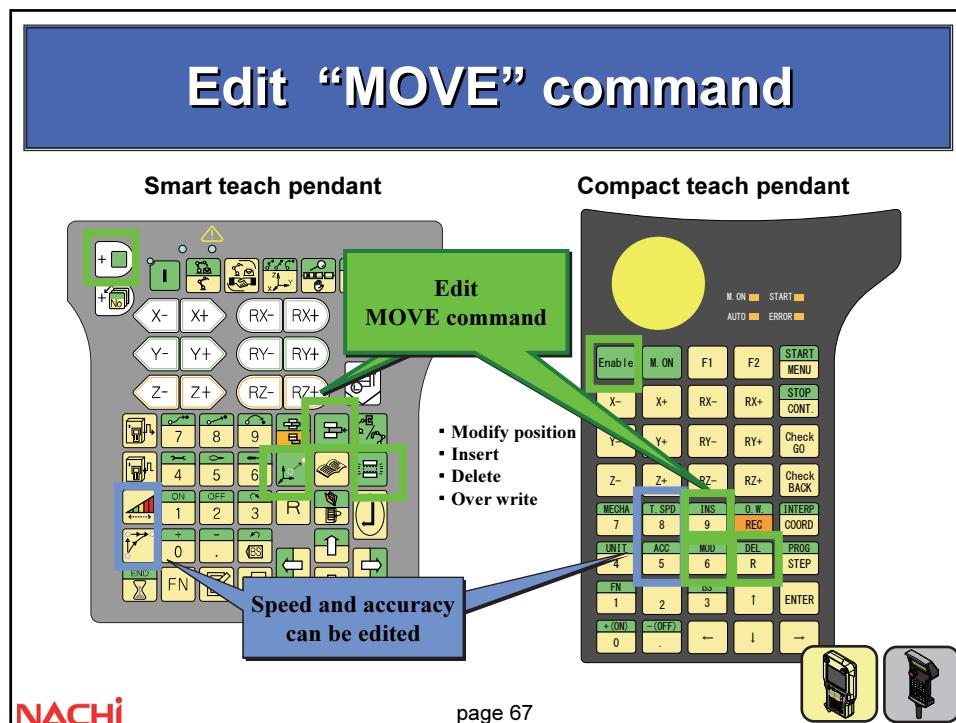
**START** Open the [START / MENU] - <SETTING> <REC STS> menu.  
**MENU** >>" REC STS" menu is displayed.



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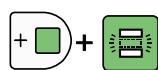




## Edit of “MOVE” command

“MOVE” command can be deleted, modified, inserted by following operation. After selecting the target step, then proceed to each operation carefully.

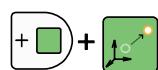
Smart TP



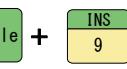
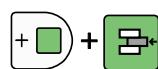
Compact TP



Selected step is deleted. Step number after the deleted step is renumbered automatically.



Only the position of selected step is modified. Other information is never changed.



New step is inserted before the selected step. Step number after the inserted step is renumbered automatically.

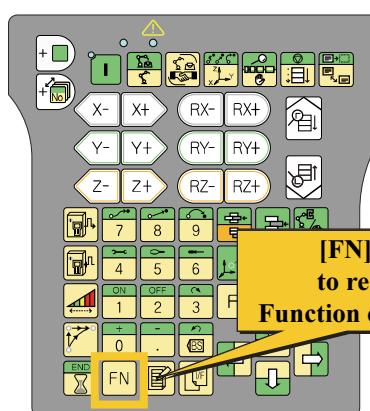
**NACHI**

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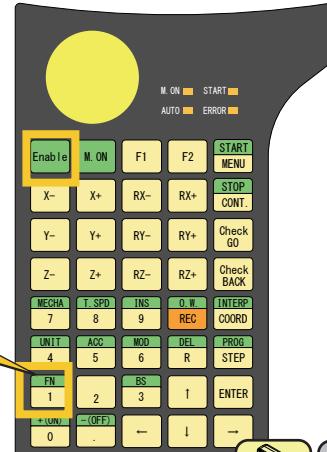


## Record “Function” command

Smart teach pendant



Compact teach pendant



[FN] key  
to record  
Function command

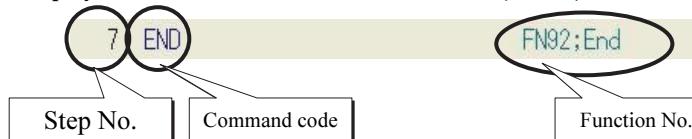
**NACHI**

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## Record “Function” command

Command without move command is called “Function” command.  
This is displayed with command code and its number (FN\*\*\*).



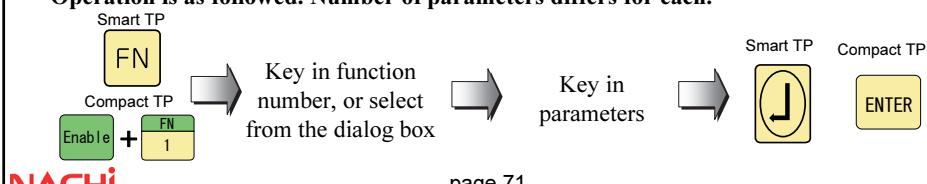
Some function has plural parameters.

(Sample)

FN119 spot welding function has 4 parameters

2	100	%	JOINT	A1	T1
3	100	%	JOINT	A1	T1
4	SPOT[1,1,1,0]				

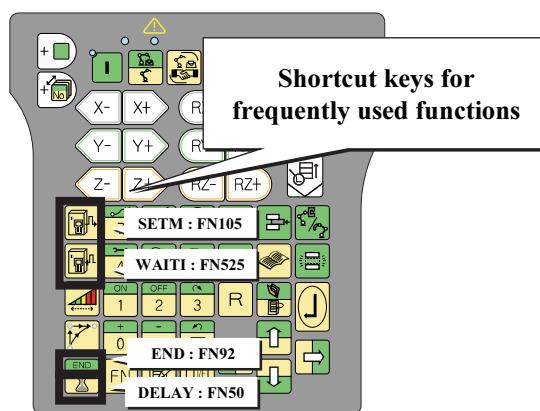
Operation is as followed. Number of parameters differs for each.



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## Frequently used Function

Smart TP



NACHI

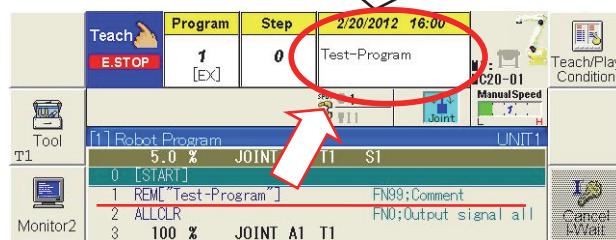
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## Frequently used Function

Very useful FN99(Comment Function)



FN99 (Comment Function) recorded at step 1 is displayed on the top of screen as the title of this program.



And, each MOVE step can keep short comment. In case of the Compact TP, the comment for a MOVE step cannot be edited. And when overwriting those steps in the Compact TP, the comments will be kept.

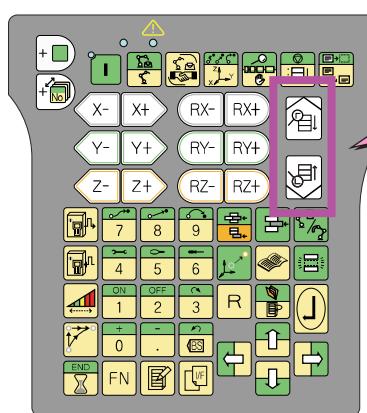
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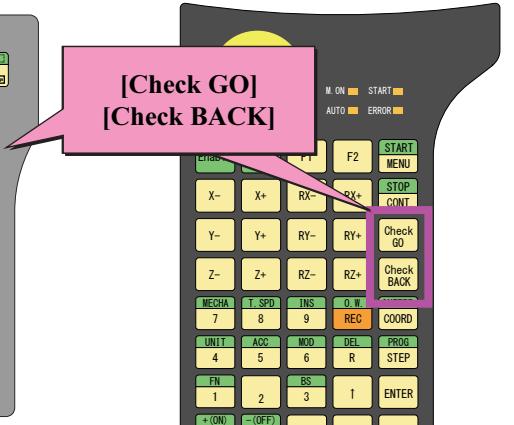


## Check the recorded program (1)

Smart teach pendant



Compact teach pendant



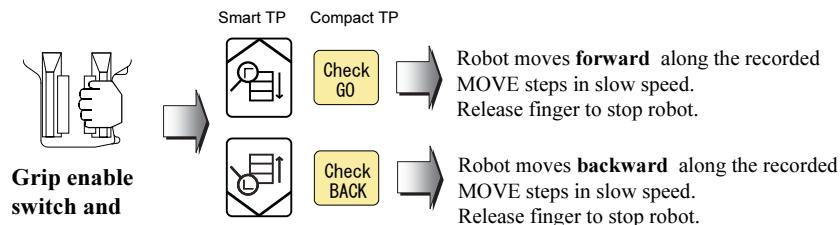
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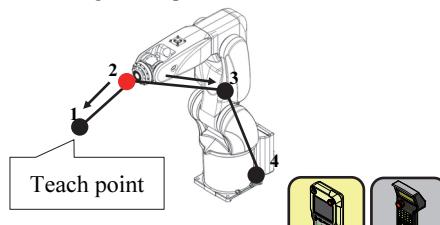


## Check the recorded program (2)

Recorded program **must be checked** before playback.  
[Check GO] and [Check BACK] keys are used.



Not only MOVE steps but also FUNCTION steps can be executed in check GO/BACK operation.  
Setting is necessary in advance.

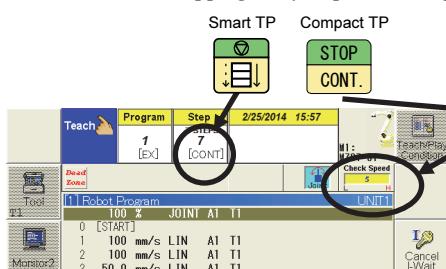


NACHI

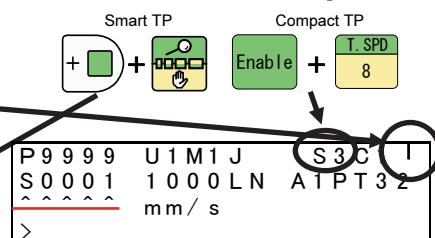
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## Check the recorded program (3)

Selection whether stopping every step or non-stop



Selection of check GO/BACK speed



No display

Robot stops at every step. Once release key and press again to move robot again.

<Smart teach pendant>  
When robot reaches to the recorded position, step display is changed to yellow.

[CONT]  
[ ]

Robot moves continuously (non-stop) until FN92:END step.

<Compact teach pendant>  
When robot reaches to the recorded position, "~~~~~" is displayed.

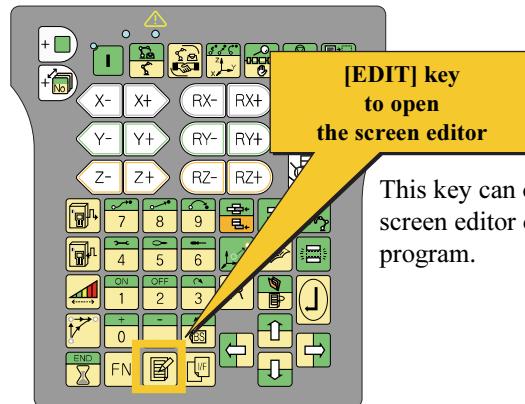
Shortcut motion is executed. So real recorded position can not be seen.

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# Screen editor

## Smart teach pendant

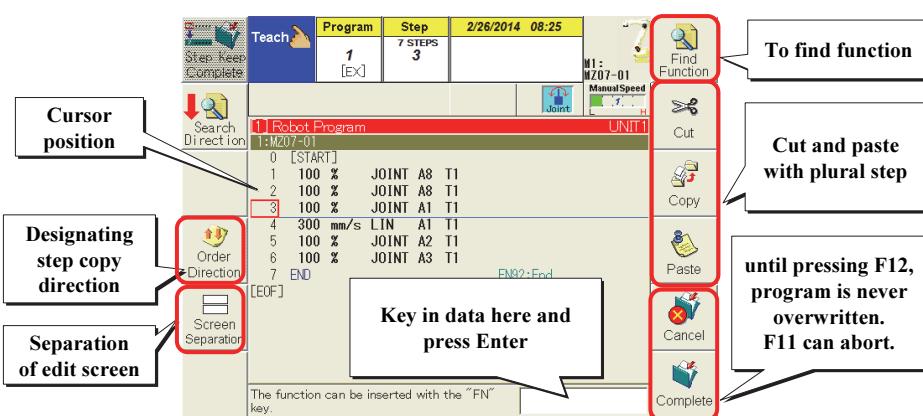


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# Screen editor



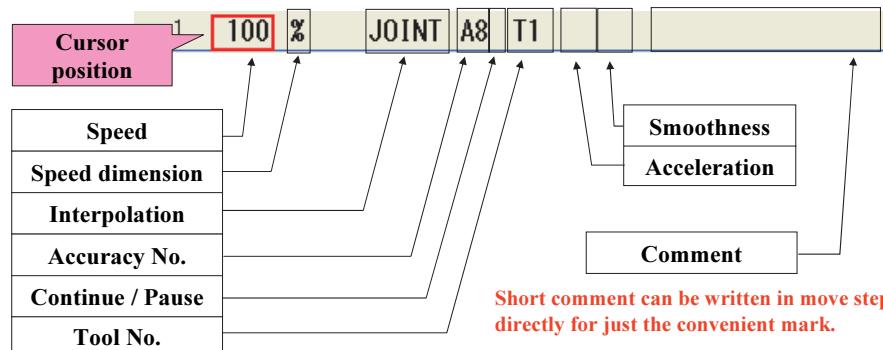
NACHI

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## Screen editor

Also information of "MOVE" command can be edited, referring the guide message displayed at the bottom of screen.

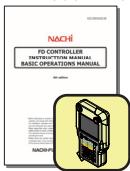


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## Section#5 Various operations for Teach

**SEE ALSO:**TCFEN-154  
CFD / START UPTFDEN-002  
FD / BASIC OPERATIONS MANUAL

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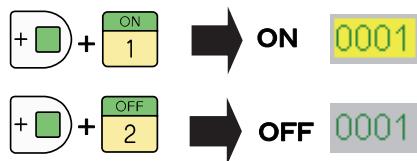
## Manual output signal ON/OFF (Smart teach pendant)



### → 8. User Outputs

File	5 100 % JOINT A2
	6 100 % JOINT A3
Constant Setting	[2] Output Signal Monitor
	0001 0002 0003 0004 0005
	0011 0012 0013 0014 0015
	0021 0022 0023 0024 0025
	0031 0032 0033 0034 0035
Service Utilities	0041 0042 0043 0044 0045
	0051 0052 0053 0054 0055
	0061 0062 0063 0064 0065

Put cursor to the output signal to be operated



Reference



This key can also drive the signal ON/OFF manually.  
Two output signals can be operated alternatively at the same time.

Prior to the operation, setting is needed in  
constant setting menu.

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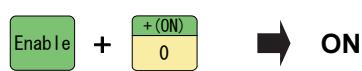
## Manual output signal ON/OFF (Compact teach pendant)



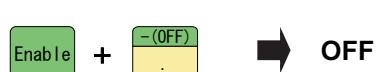
→ [MONITOR]→[OUTPUT]

*	M	E	N	U	*	O	U	T	P
O	0	0	3	1	-	-	-	-	-
O	0	0	4	1	-	-	-	-	o
O	0	0	5	1	-	o	-	-	-

Put cursor to the output signal to be operated



*	M	E	N	U	*	O	U	T	P
O	0	0	3	1	-	-	-	-	-
O	0	0	4	1	-	-	-	-	o
O	0	0	5	1	-	o	-	-	-



*	M	E	N	U	*	O	U	T	P
O	0	0	3	1	-	-	-	-	-
O	0	0	4	1	-	-	-	-	o
O	0	0	5	1	-	-	-	-	-

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## Manual output signal ON/OFF (Compact teach pendant)

### Turning ON/OFF the general output signal manually with F1 key

In case of the Compact teach pendant, output signal can be turned ON/OFF manually with the F1 key. When 2 output signals are assigned, those signals can be operated alternatively at the same time. This function can be used only in the “Teach mode” and the “Playback mode (Step by step)”.

**START**  
**MENU**

Press [START/MENU] and select <SETTING>- <F-KEY>.   
>>F-KEY menu is displayed.

*	M	E	N	U	*	F	-	K	E	Y	V	3	.	0	7
<	F	1	K	E	Y	>	0	0	0	1	0	0	0	2	
	F	2	K	E	Y		I	C	a	n	c	e	I		
>															

**ENTER**

Move cursor to <F-KEY> and press [ENTER].  
>> “O” is display in prompt line.

*	M	E	N	U	*	F	-	K	E	Y	V	3	.	0	7
<	F	1	K	E	Y	>	0	0	0	1	0	0	0	2	
	F	2	K	E	Y		I	C	a	n	c	e	I		
>	O														

[Continue to next page](#)



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## Manual output signal ON/OFF (Compact teach pendant)

With numeric keys, input the general output signal number to be assigned to F1 key. (0 to 2048)  
Here, “3” is inputted as sample.

>> “O3” is display in prompt line.

*	M	E	N	U	*	F	-	K	E	Y	V	3	.	0	7
<	F	1	K	E	Y	>	0	0	0	1	0	0	0	2	
	F	2	K	E	Y		I	C	a	n	c	e	I		
>	O	3													

**ENTER**

Press [ENTER].

>> First output signal is changed to “0003”.

*	M	E	N	U	*	F	-	K	E	Y	V	3	.	0	7
<	F	1	K	E	Y	>	0	0	0	3	0	0	0	2	
	F	2	K	E	Y		I	C	a	n	c	e	I		
>															

Next, second output signal number and press [ENTER].

If only one signal is enough, please input “0” to second signal.

**START**  
**MENU**

Press [START / MENU] again to go back to the top screen.

**Enable**

**+ F1**

Press [Enable] + [F1].

>> Designated output signal on/off is changed alternatively.

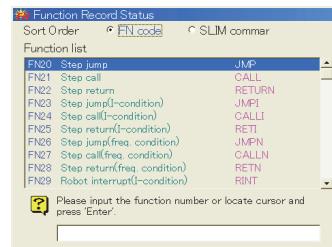


**NACHI**

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## HELP message

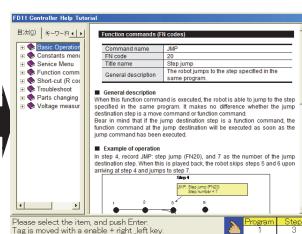
Put cursor to the unknown function



### Reference

If [HELP] key is press at the top screen, whole of help menu will appear.

Detail explanations will appear



List box and contents box can be switched by



to close help screen.



NACHI

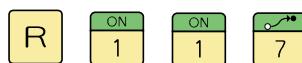
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## Useful shortcut (R code)

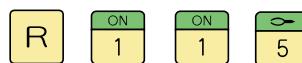
At the top menu, try to press key and 2 or 3 digit number . . .



Program list display



Program deletion



Program copy and so on . . .

You can achieve to the needed operation faster than normal menu operation.

(However ,there are some shortcuts that are not available in case of the Compact teach pendant)

Very useful if you remember this number



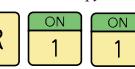
NACHI

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## Copying of program

### ■ To copy program No.3 to No.33

At the top menu



Copy source program number



Copy target program number



- Also copy operation is proceeded in program selection diagram.

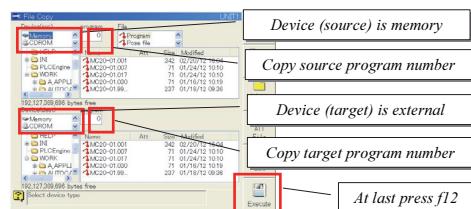
- Furthermore there is copy menu in file manager.

- Also in case of the Compact TP, this short cut code R115 is available.



### ■ To copy program to the another robot (another controller)

- Utilize the copy menu in file manager to/from the external memory device.



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## Section#6 Playback

SEE ALSO:

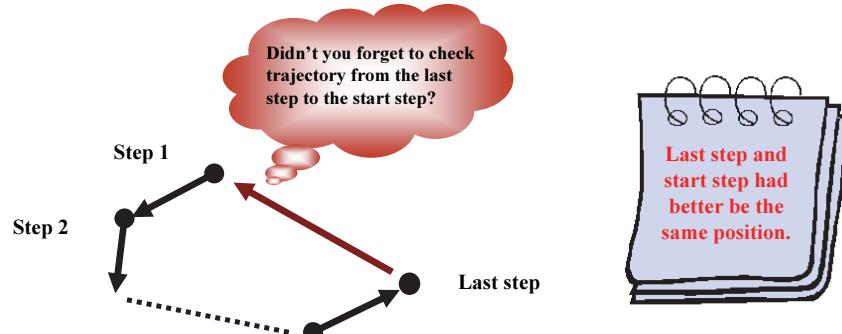
TCFEN-154  
CFD / START UPTFDEN-002  
FD / BASIC OPERATIONS MANUAL

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## Playback program

**Check**

All the trajectory checking is really done by check GO/BACK operation?



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## Playback program

**1**

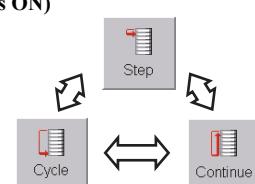
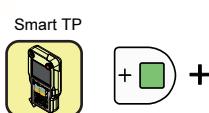
Change to playback mode.



In playback mode, enable switch is disabled.  
(Motor power is ON)

**2**

Select one playing mode.



## (NOTE)

For the 1<sup>st</sup> playback check operation, "Step" or "Cycle" is recommended.



number → ENTER

0;1s (Step)  
1;Cy (Cycle)  
2;Co (Continue)

NACHI

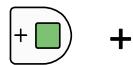
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## Playback program

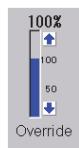
**3**

**Reduce the playback speed by “Velocity override”.**

Smart TP



+

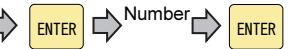
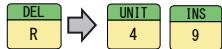


Playback speed can be temporary reduced without program modification.

Recorded speed      Velocity O/R      Playback speed

Ex) 1200mm/sec     $\times$  50% = 600mm/secEx) 90%             $\times$  20% = 18%

Compact TP



In case of the Compact teach pendant, the Override can be changed only by this shortcut code.



**Sudden playback with top speed is very dangerous. Unexpected interference with the peripheral equipments, big vibration of application wires and dropping off the work-piece may happen. New program must be checked with sufficient low speed (ex: 20% to 30%) using velocity override.**

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**4**

**Confirm the current step No. and current robot position.**

Current step No.



Robot moves  
from current position  
to this step.



- Intermediate step is not set?
- Robot position is correct?
- Conditions of peripheral equipment such as gripper is correct?
- For the playback from start step, select step 0.

When immediately after the END step playback is completed, this is same. When playback is started, robot jumps to the top of this program (= step 0) after END step.

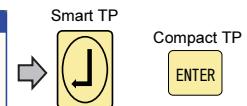
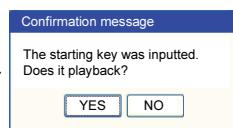
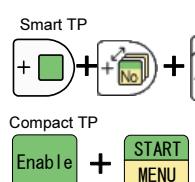
**NACHI**

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## Playback program

5

**Place your finger on the Emergency stop button, check the peripherals around the robot, and start the program.**



When this dialog window shows up, select "YES" and press [Enter] to start.

- If robot moves to the different position or with the different speed with your expectation, **immediately press emergency stop button without hesitating.**

Teaching mistake? Wrong program No.? Wrong step No.? And or so.

- After checking finished, **increase the speed gradually and try again.**
- After 100% O/W is finished, checking is completed at this moment.

Velocity override can be set larger than 100% value. Please use this utility to try the tact up.

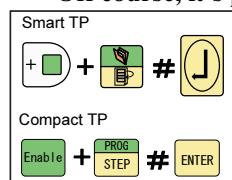
NACHI

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## Playback program

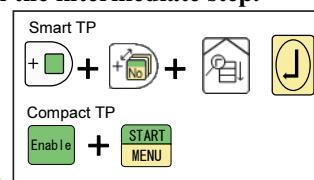
**Off course, it's possible to playback from the intermediate step.**



Select the start step and start playback

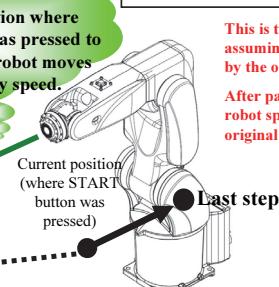
From the position where START button was pressed to step # position, robot moves in slow safety speed.

Step 1 ●  
Step 2 ●  
Step # ●



This is the safety countermeasure assuming the mistaken selection by the operator.

After passing through step #, robot speed is raised up to the original speed.



<Note> Function command can not be selected as the start step. Because it's very dangerous to execute function at the different step from the correct position.

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## Brushing up the program

6

Finish the programming by removing the useless motion, by checking the following items and or so, to make robot faster.

- NO place to hit the peripheral equipment? (Be sure to perform the continuous check go/back.)
- All move command is smoothly connected? (no sudden acceleration.)
- No useless motion? (Unnecessary point, unnecessary delay, and or so)
- Unnecessary big motion to make overload? (This is very important to make robot lifetime longer.)

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**NACHI**  
Robot school

**CFD standard course**

### **Setup**

Section#1: Carrying, installation and connection  
Section#2: Safety signals  
Section#3: I/O signals  
Section#4: Payload (Tool)  
Section#5: Constant Setting

NACHI

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**NACHI**  
NACHI-FUJIKOSHI CORP.

## Section#1 Carrying, Installation and Connection

**SEE ALSO:**

TCFEN-154  
CFD / START UP

NACHI  
CONTROLLER  
INSTRUCTION MANUAL  
START UP

NACHI-FUJIKOSHI CORP.

**NACHI**

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## Carrying robot

Referring to the robot maintenance manual, carry and install robot by proper method.

Robot COG position should be in center and lower

Proper wire quantity, length and thickness by referring to the manual

Protect arm where the wire contacts arm Directly. (use rubber cover and or so)

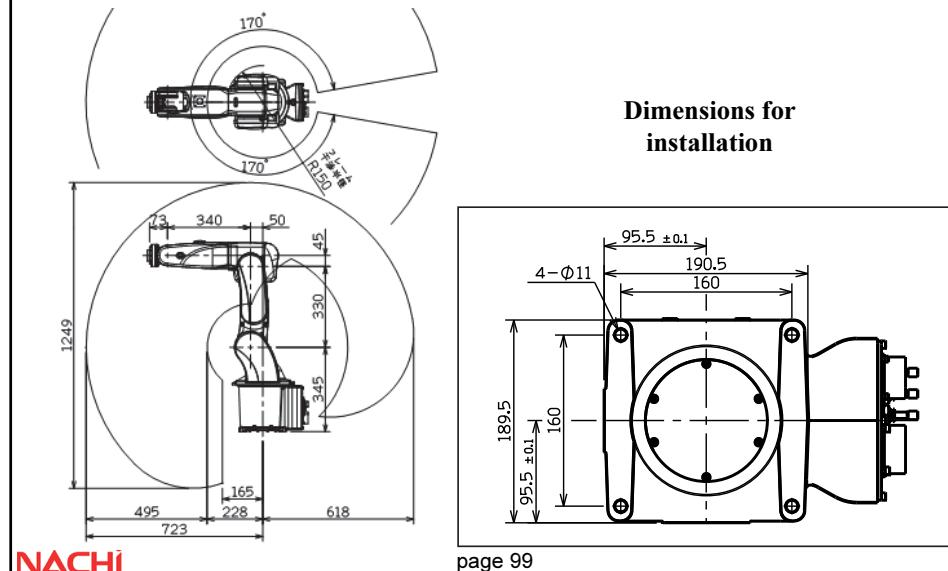
After installation, remove the axis 2 fixing bracket.

Please refer to robot maintenance manual (manipulator) for detail.

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## Installation of robot

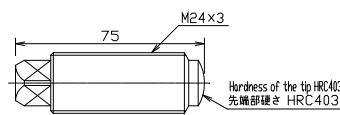


## Installation of robot

Clearance of four mounting plates  
should be  
within 0.2 mm +/- 0.1 mm.

Flatness of four mounting plates  
should be  
within 0.2 mm

If above two requirements were  
difficult, use jack bolt to contact  
four point equally.



**If four mounting points do not contact to the floor equally, robot  
position may be unstable and lifetime may be shortened.**

Please refer to robot maintenance manual (manipulator) for detail.

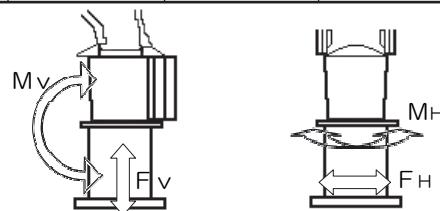
**NACHI**

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## Installation of robot

### Stiffness of robot raiser

Robot type	Max. Vertical Generative force FV	Max. Horizontal Generative force FH	Max. Vertical Generative moment MV	Max. Horizontal Generative moment MH
MZ07-01 MZ07P-01	1,600 N	1,200 N	1,000 N·m	900 N·m
MZ07L-01 MZ07LP-01	2,000 N	1,500 N	1,250 N·m	1,130 N·m



Please refer to robot maintenance manual (manipulator) for detail.

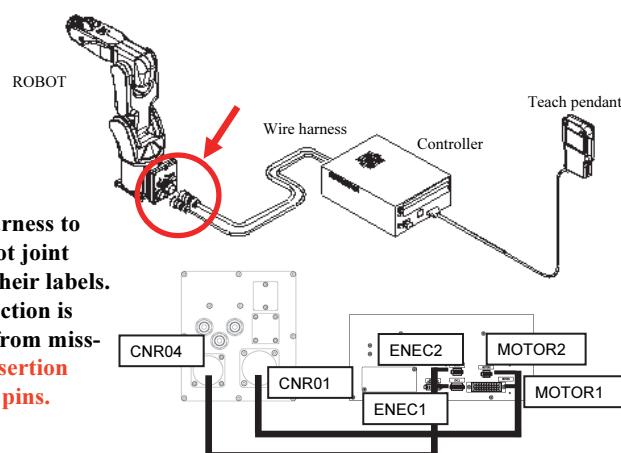
NACHI

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## Connect robot and controller

Connect robot and controller with “wire harness (control cables)”.

Before connecting harness to the receptacle of robot joint box, please confirm their labels. Although its key direction is designed to prevent from mismatching, **forcible insertion will break connector pins.**

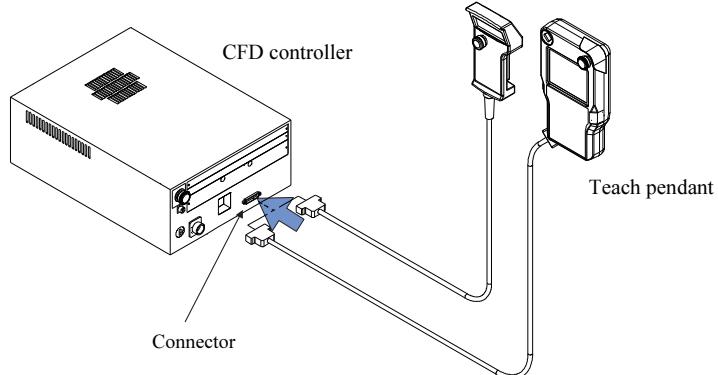


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## Connect teach pendant

Connect teach pendant to controller.



## Primary power connection

### Before connection

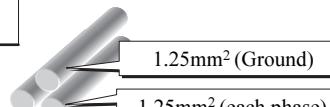
- Turn OFF the power supply and main circuit breaker of controller.
- Check the primary power voltage. Controller specification is labeled near the main circuit breaker

**DANGER** If connected keeping power ON, operator may be seriously injured.

**CAUTION** Wrong voltage may break the controller circuit.

Manipulator	Rated voltage	Power-handling capacity (NOTE)
MZ07-01 / MZ07P-01	3-phase AC200V-230V	
MZ07L-01 / MZ07LP-01	Single-phase AC200V-230V (+10%, -10%) 50/60 Hz	0.4 kVA

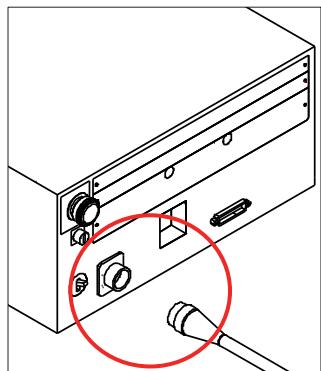
Connector pin layout Seeing from the soldering side	PIN No.	Connection	
		3-phase AC200V	Single-phase AC200V
	1	AC200V R-Phase (RED)	AC200V R-phase (RED)
	2	AC200V S-phase (WHITE)	-
	3	AC200V T-phase (BLACK)	AC200V T-phase (BLACK)
Applicable cable diameter: 10~12.5 [mm]	4	Ground (Y/G)	Ground (G/Y)
Connector type Nanaboshi Electric Mfg.Co.Ltd NJC-204-PF			



For the power lines, the cross-section of each phase must be 1.25mm<sup>2</sup> or more.

For the ground line, the cross-section of the line must be 1.25mm<sup>2</sup> or more.

## Primary power



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



**CAUTION**  
For safety, apply "Type D ground" for the grounding line (This is less than 100 ohms). (The grounding wires should be prepared by customer)

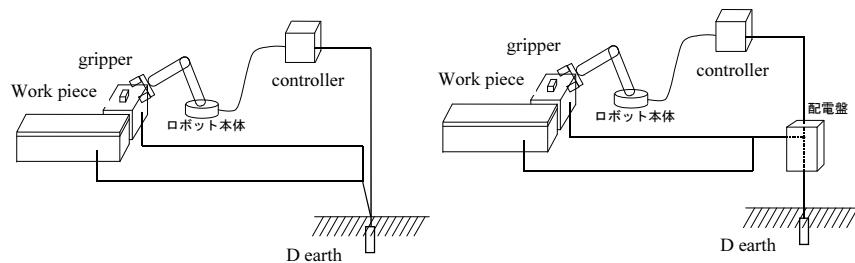
For the power lines, the cross-section of each phase must be 1.25mm<sup>2</sup> or more.

For the ground line, the cross-section of the line must be 1.25mm<sup>2</sup> or more.

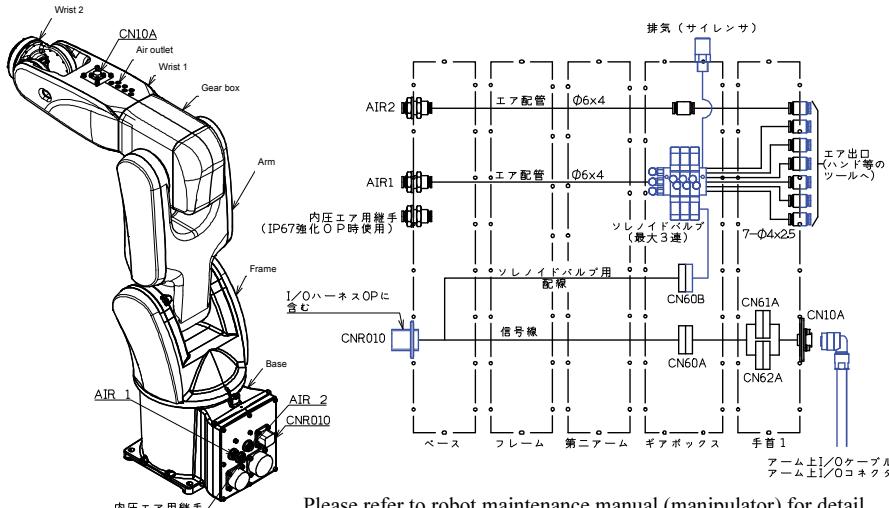
## Grounding

- Grounding of controller is absolutely necessary to prevent from the receiving an electric shock and noise. (More than 1.25 mm<sup>2</sup> wire must be used for grounding wire, and wire length had better be as short as possible. (D earth : grounding resistance less than 100 ohms)

- Also peripheral equipment must be grounded to make same voltage level.



## Application wires and tubes



Please refer to robot maintenance manual (manipulator) for detail.

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Base Frame Arm Gear box Wrist 1



## Section#2 Safety signals

*SEE ALSO:*

TCFEN-154  
CFD / START UP



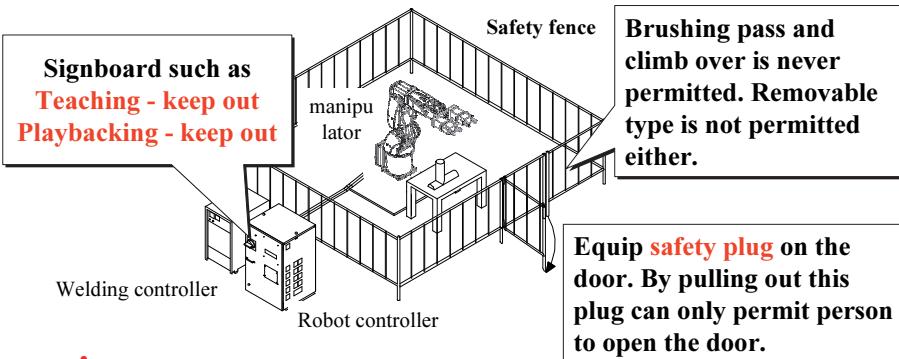
**NACHI**

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## Safety signals

### Installation of safety fence (sample)

Safety fence (robot surrounding fence) must be installed to protect operators. Otherwise robot may hit the operator and serious injuring may happen.



NACHI

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## Precautions for the guard fence (example)

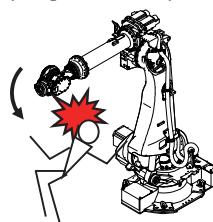
(1) When entering into the area surrounded by the guard fence, do not forget to stop the peripheral equipments and the robots.

(Turn OFF their power source or press the Emergency stop button to lock)

***Even if the robot seems to be stopping, it may be just waiting for the interlock release signal and be ready for the restart*** (that means the robot can restart immediately via external input signals / sensors etc.) Therefore, do not forget to turn OFF (and lock-out) their power source or press their Emergency stop button to secure the safety.

(2) Connect the wiring for the "Safety-plug" without fail and install the safety-plug onto the entrance door of the production area so that the robot stops its program playback immediately when the safety-plug is pulled-out. This is one of the very important safety-related equipments. Disabling equipments like this is strictly prohibited.

***If these things are not kept,  
serious injury or death may  
be caused!***



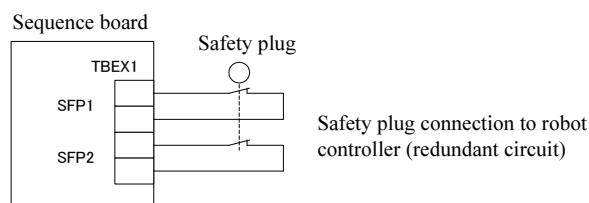
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## Safety signals

(1) Make the safety fence preventing from brushing pass or climbing over by operator. Removable type fence is NG also.

(2) Install the door to get in the safety fence and equip the **safety plug**. By pulling out this plug can only permit person to open the door.

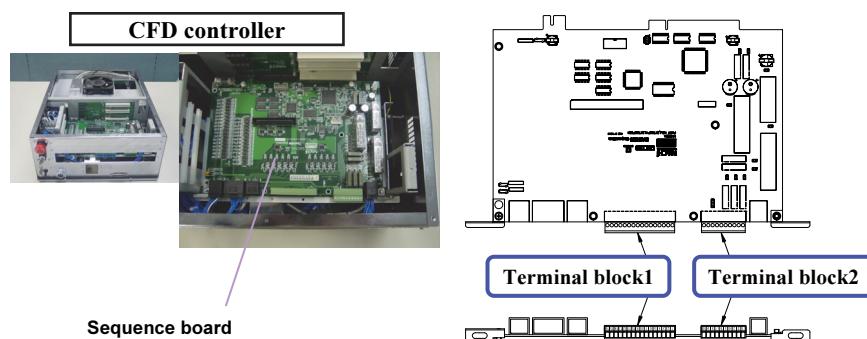


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## Safety signals

Connect the safety-related signals (e.g. External emergency stop, Safety-plug, etc.). These are the absolutely necessary signals to keep the teaching (programming) operators in safe or to stop the robot in case of emergency.



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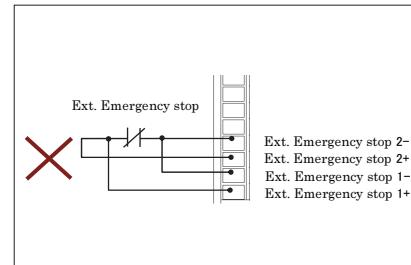
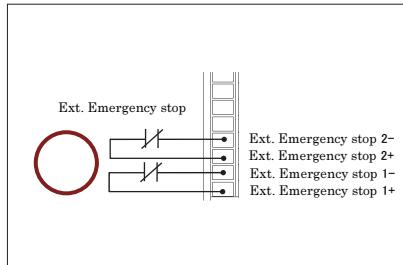
## Safety signals



CAUTION

Robot controller equips redundant circuit  
in safety logic. Independent two input  
signals must act completely same.

### Ext. Emergency stop input



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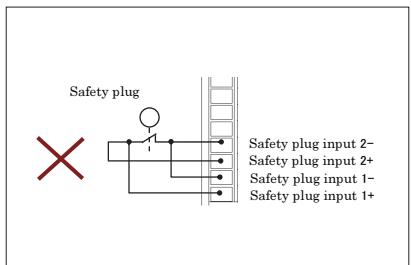
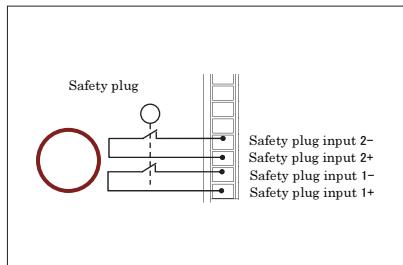
## Safety signals



CAUTION

Robot controller equips redundant circuit  
in safety logic. Independent two input  
signals must act completely same.

### Safety plug input

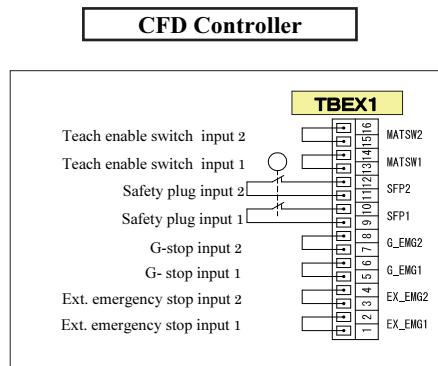


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## Connection for stand alone robot

If robot is used in stand alone style, external emergency stop and teach enable switch and G-stop signal must be connected as shown below.

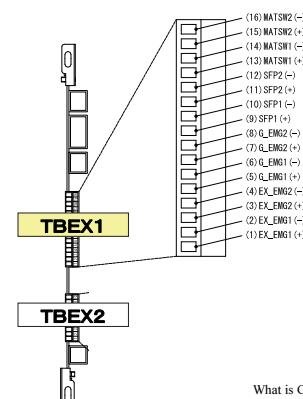


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## Safety signals connection

Sequence Board



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.
15	MATSW1	Teaching enable switch input 2+	When not using this terminal, connect jumper wires as shown below. Connect 13 and 14 Connect 15 and 16
14	MATSW1	Teaching enable switch input 1-	
13		Teaching enable switch input 1+	
12	SFP2	Safety plug input 2-	
11		Safety plug input 2+	This is a safety plug input terminal. Connect always.
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. Connected 5 and 6 Connected 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.
3		External emergency stop input 2+	When not using this terminal, connect jumper wires as shown below. Connected 3 and 4
2	EX_EMG1	External emergency stop input 1-	When not using this terminal, connect jumper wires as shown below. Connected 1 and 2
1		External emergency stop input 1+	

What is G-STOP?

In any occasion, robot stops immediately and magnet switch is turned OFF when "G-STOP input signal" is opened. But motor power (servo power) remains being ON. This point is different from emergency stop. After that, when "G-STOP reset input signal" (assigned signal) is turned ON and "G-STOP input signal" is closed, magnet switch is turned ON and robot is automatically restarted.

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**SEE ALSO:**

TCFEN-154  
CFD / START UP

TCFEN-154  
CFD / TECHNICAL DOCUMENT2

**Chapter1**

NACHI  
CFD CONTROLLER  
INSTRUCTION MANUAL  
START UP

NACHI  
CFD CONTROLLER  
TECHNICAL DOCUMENT 3

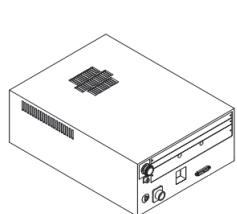
**NACHI**

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## What is I/O signal?

Communication between controller and peripheral equipment

### Robot controller



Output signals

Home position  
signal, error signal, etc.

### Peripheral equipment

sensor,  
switch,  
PLC,  
and or so

including other  
robot controller

Input signals

Program selection signal,  
start command,  
interlock signal, etc.

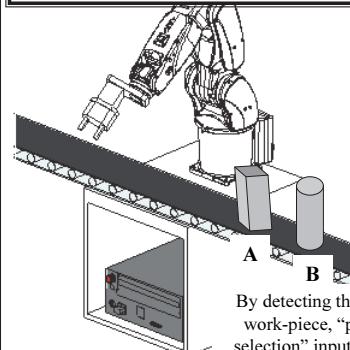
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## What is I/O signal?

For example, robot program number can be selected by input signal depending on the type of work.

The CFD controller and the robot (with the I/O signal interface)



By detecting the type of work-piece, "program selection" input signal is determined.

Program sel. bits U1 1 17 2 18 3 19 4 20  
5 21 6 22 7 23 8 24

Next work-piece is type "A"  
so program No. is 100

100 [Decimal value]  
=  $64 + 32 + 4$   
=  $2^6 + 2^5 + 2^4 + 2^3 + 2^2 + 2^1 + 2^0$   
= 0110 0100 [Binary value]

I24	I23	I22	I21	I20	I19	I18	I17
OFF	ON	ON	OFF	OFF	ON	OFF	OFF

0011	0012	0013	0014	0015	0016	0017	0018	0019	0020
0021	0022	0023	0024	0025	0026	0027	0028	0029	0030

Ext. play start U1 30

It's time to start!

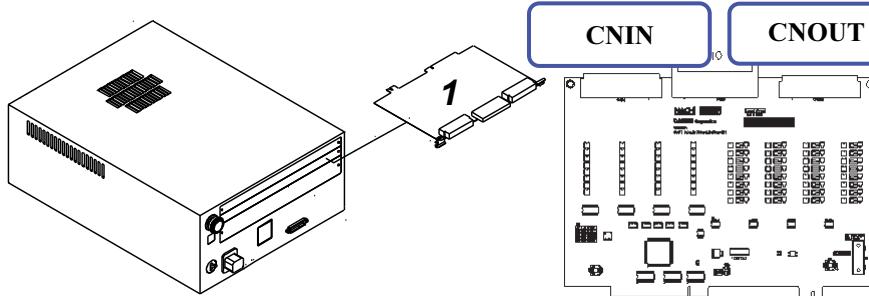
"External playback start (I30)"  
is turned ON. 0030

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## DC24V I/O signals

In case of DC24V I/O specification, input and output signals are connected to CNIN and CNOOUT connectors on I/O board.



CFD controller option - DC24V Digital I/O board : CFD-OP125-A (NPN)  
CFD-OP151-A (PNP)

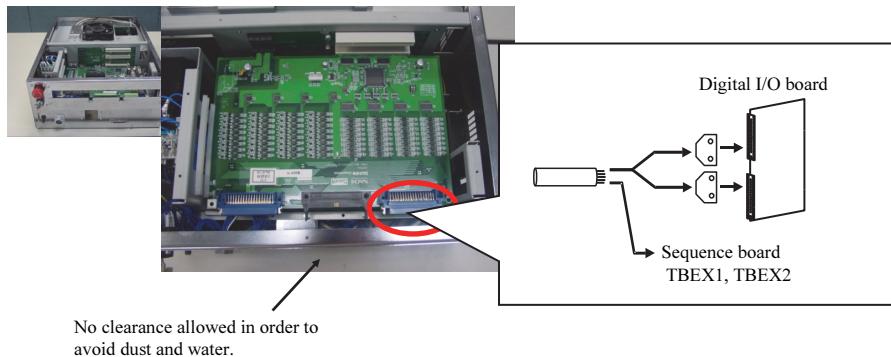
Not only DC24V I/O, but also field bus such as DeviceNet, PROFIBUS,etc. is available.

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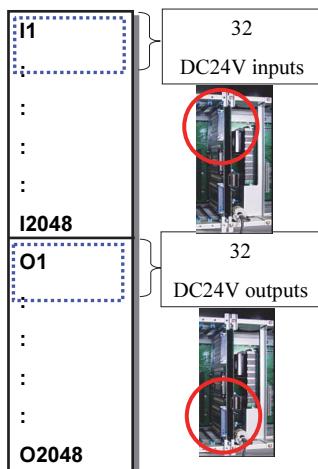
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## DC24V I/O signals

Solder necessary cables to the I/O connectors (CNIN / CNOUT), and connect them to the Digital I/O board. Then attach the front panel on the CFD controller securely without clearance.



## DC24V I/O



### Input signal (I1~I2048) “I signal”

32 points of DC24V input signals are supported as standard (I1 to I32).  
Please use these signals as start/stop command input and or so from peripheral equipment.

### Output signal (O1~O2048) “O signal”

32 points of DC24V output signals are supported as standard (O1 to O32).  
Please use these signals as home position signal, interlock signals, etc. to peripheral equipment.

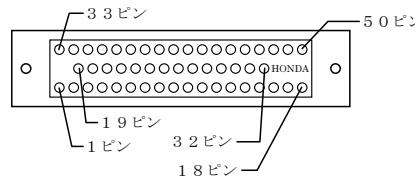
For details, please refer to the “Chapter 3 Digital I/O” in the “Technical document 2”.

## DC24V I/O

### Input signal connector CNIN

View from solder pot side

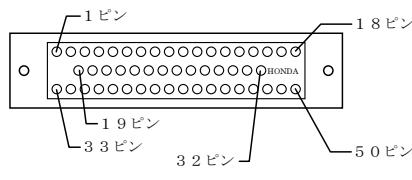
Type : MR- 50LM (Honta Tsushin)



### Output signal connector CNOUT

View from solder pot side

Type : MR-50LF (Honta Tsushin)



**I/O signals are free to be assigned to general usage I/O signals or status I/O signals (that already has some meaning for the controller, such as “start” signal).**

Please refer to “Setup manual (FD)” for details.

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## Status I/O assignment

**Status input (output) signals are allocable in I1 to I2048 (O1 to O2048) signals.**

Frequently used I/O signals are already assigned when shipped. But all signals are free to be re-allocated.

Standard inputs		1/6
Ext. play start	U1	30
Ext/unit play stop	U1	0
Ext. All unit play stop	U1	0
Ext-unit play stop	U1	31
MotorsON external		29
MotorsOFF external		32
Program sel. bits	U1	Refer
	1  17   2  18   3  19   4  20	
	5  21   6  22   7  23   8  24	
	9  30   10  0   11  0   12  0	
	13  0   14  0   15  0   16  0	

For example, “External playback start” input signal is assigned to I30 in above figure. Robot starts playback when I30 is inputted from external controller.

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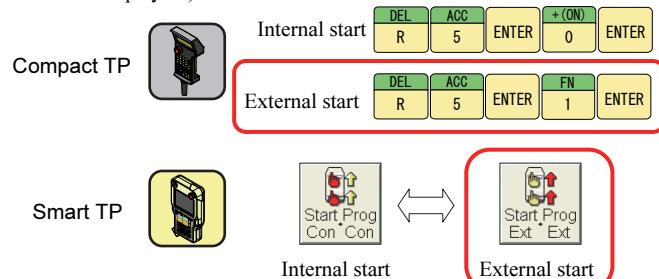
## External Motors ON signal

To turn the Motors ON using external input signal from a PLC etc., it is necessary to assign the “**Motors ON external**” signal to an input signal in advance.  
(In this example, I29 (input signal No. 29) is assigned to the “**Motors ON external**”.



In addition, to use this signal, it is necessary to switch the operation mode from “**Internal start**” to “**External start**” in advance. (If the “Motors ON external” is turned ON in the “Internal start” mode, an error is displayed.)

EXCLURE play SWP	01	01
MotorsON external	29	
MAIN OFF	00	00



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*SEE ALSO:*TCFEN-154  
CFD / START UPTFDEN-001  
FD / SETUP MANUAL

Chapter1

Chapter4



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Before starting this section, the operator must learn how to operate the robot (teach and playback).

## “3 Requirements” for tool

**There are 3 requirements for tool payload,  
those are**

**Rated Weight**

**Rated Torque**

**Rated Inertia**

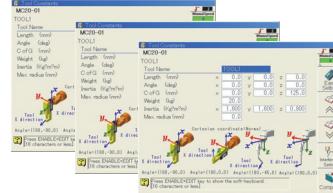
**Please comply these requirements when  
designing tool payload.**

## Rated weight of tool

**Tool payload weight must not be over the rated weight.**

Robot type	Rated weight of payload
MZ07-01, MZ07L-01	<b>7 kg or less</b>
MZ07P-01, MZ07LP	<b>7 kg or less</b>

**For material handling  
application, tool weight is  
gripper weight + work-piece  
weight.**



If work piece shape and weight varies much,  
register tool constant for each tool.  
But if they are similar, plural tool constants  
are not necessary.



## Rated torque of tool

Tool payload torque must not be larger the rated torque. Torque is determined by the weight and COG of payload.

Robot type	Rated torque of payload		
	Rotating on axis 4	Rotating on axis 5	Rotating on axis 6
MZ07-01, MZ07L-01	16.6 N·m or less	16.6 N·m or less	9.4 N·m or less
MZ07P-01, MZ07LP-01	—	16.6 N·m or less	9.4 N·m or less

### [calculation example]

In case of MZ07-01, try to calculate the distance how far the 5 kg payload COG can exist from axis 6 rotating center.

$$(\text{Rated torque of rotating on axis 6 [Nm]}) / (\text{weight [kg]} * 9.8[\text{m/s}^2])$$

$$= 9.4 / (5 \times 9.8) = 0.2[\text{m}]$$

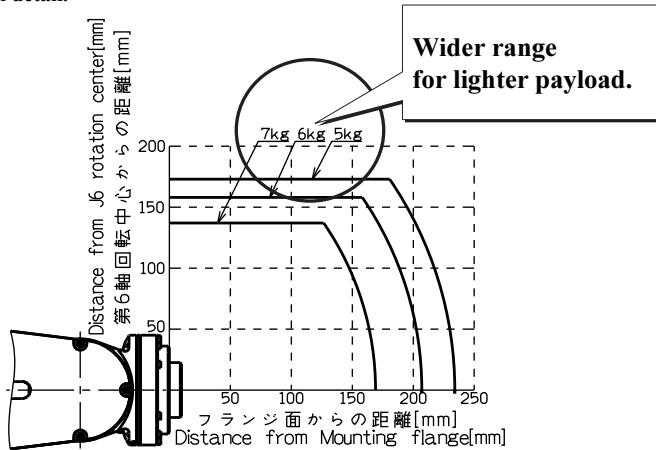
Therefore, COG of 5 kg payload must exist within 0.2m distance from the center of axis 6 rotating center.

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## Rated torque of tool

Specification of rated torque is represented by visible graph here, called "torque map". When tool weight and its COG is fixed, try to plot on this map at first. If it is closed to the limited line, then calculate in detail.



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## Rated inertia of tool

Tool payload inertia must not be larger than the rated inertia. Inertia is determined by the weight and COG of payload.

Robot type	Rated inertia of payload		
	Rotating on axis 4	Rotating on axis 5	Rotating on axis 6
MZ07-01, MZ07L-01	0.47 kg·m <sup>2</sup> or less	0.47 kg·m <sup>2</sup> or less	0.15 kg·m <sup>2</sup> or less
MZ07P-01, MZ07LP-01	—	0.47 kg·m <sup>2</sup> or less	0.15 kg·m <sup>2</sup> or less

### [calculation example]

In case of MZ07-01, try to calculate the inertia when 5 kg payload COG is 0.1 m far from the axis 6 rotating center.

$$(Inertia) = (\text{weight}[kg]) * (\text{distance from the rotating center [m]})^2$$

$$= 5 * 0.1^2$$

$$= 0.05 [\text{kg} \cdot \text{m}^2]$$

$$\text{Its torque is } 5\text{kg} * 9.8 * 0.1\text{m} = 4.9 [\text{N}\cdot\text{m}]$$

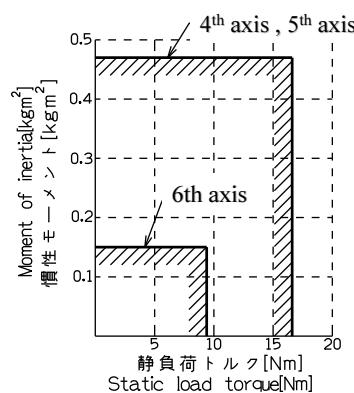
By referring to the inertia map, inertia 0.05 [kg · m<sup>2</sup>] is under the limit. So this is no problem.

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## Rated inertia of tool

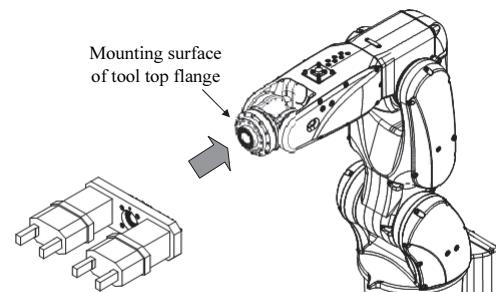
Specification of rated inertia is represented by visible graph here, called “inertia map”. Inertia differs depending on the torque. When tool weight and its COG is fixed, try to plot on this map at first. If it is closed to the limited line, then calculate in detail.



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## Mounting tool



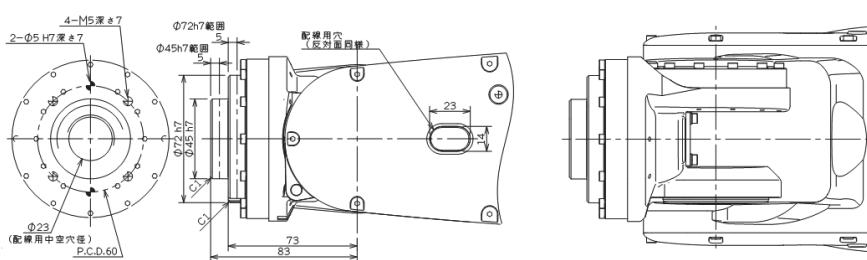
Operate the robot manually to good posture for the safe work.  
When mounting tool, it's not necessary that tool direction is vertically upward or downward.

"TOOL" is called "End Effector" in other word.

NACHI

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## Mounting tool



Depth of fixing bolts are never longer than specified depth of the holes on mounting surface. If longer bolts are used, wrist may be broken.

Please refer to robot maintenance manual (manipulator) for detail.

NACHI

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## Encoder correction at first (recommended)

At NACHI factory, encoder correction is performed under the load condition and robot posture specified by NACHI. This load condition and robot posture may have influence on the reference position. So please perform encoder correction for all axes

after all of the load are mounted on wrist and forearm,

before staring the teaching procedure,

If encoder correction is carelessly performed after teaching is done, all of the taught points are needed to be modified because tool top position may change largely.

Also encoder correction is necessary when motor / encoder is replaced.

At this time, encoder correction must be performed under the same load condition and same robot posture as the first time encoder correction that is performed immediately after the loads are mounted,

because load condition and robot posture may have influence on the reference position. Therefore, the “reference posture” (where all axes are in “reference position” by using zeroing pin or like that) is recommended as the posture of encoder correction.

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## Section#5 Constant Setting

*SEE ALSO:*

TFDEN-001  
FD / SETUP MANUAL

*Chapter4*



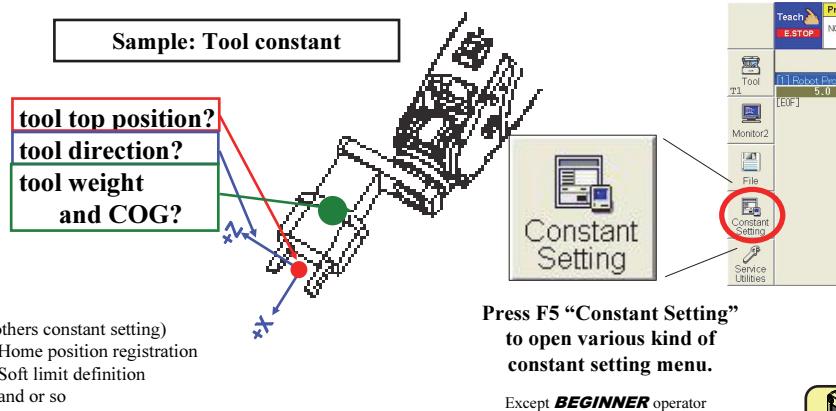
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Before starting this section, the operator must learn how to operate the robot (teach and playback).

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## What is “constant setting”?

**Constant setting = Set up parameters before beginning teach**  
**This work must be finished before beginning teach.**



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## Tool constant



[3 Machine Constant]

[1 Tool Constant]

Tool Constants			
MC20-01			
TOOL1			
Tool Name	TOOL1		
Length (mm)	x: 0.0	y: 0.0	z: 0.0
Angle (deg)	x: 0.0	y: 0.0	z: 0.0
C of G (mm)	x: 0.0	y: 0.0	z: 125.0
Weight (kg)	20.0		
Inertia (Kg <sup>2</sup> m <sup>2</sup> )	x: 1.600	y: 1.600	z: 0.800
Max. radius (mm)	0.0		

Cartesian coordinate=Normal

Tool direction X direction Tool X direction Tool X direction Tool X direction

Angle=(180,-80,0) Angle=(180,0,0) Angle=(180,-45,0) Angle=(180,0,0)

Press ENABLE+EDIT key to show the soft-keyboard.  
[16 characters or less]

Tool name

Tool length

Tool angle

Tool weight &amp; COG

Tool inertia

Tool rotating radius



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## Tool constant

### Tool length

This is to define where the tool top position is. It's length (X,Y and Z value) is measured from the tool attaching plate.

### Tool angle

This is to define the tool direction. It's angle is measured as rotating angle on X,Y and Z axis.

### Tool weight & COG

(**EXPERT** or upper operator level is necessary to set this.)

This is to define where the tool COG position is. Also its weight is set. These parameters are necessary to make an adequate acceleration control.

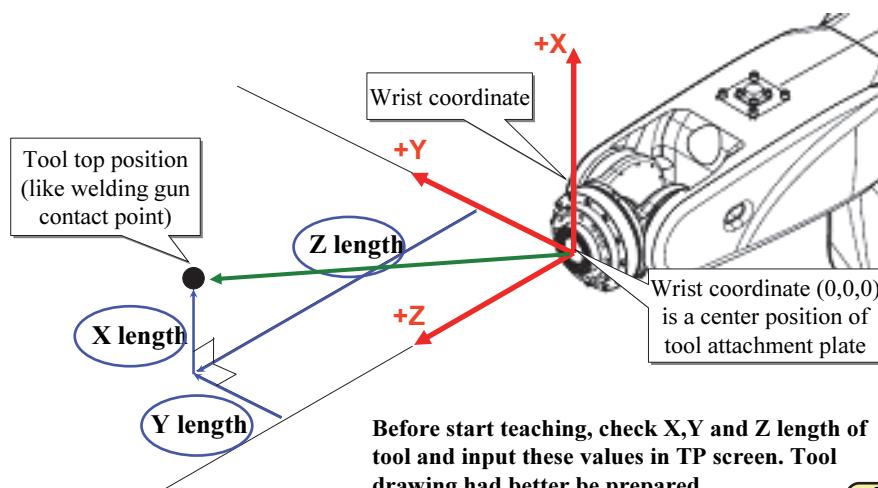
### Tool inertia

This is to define the tool inertia.

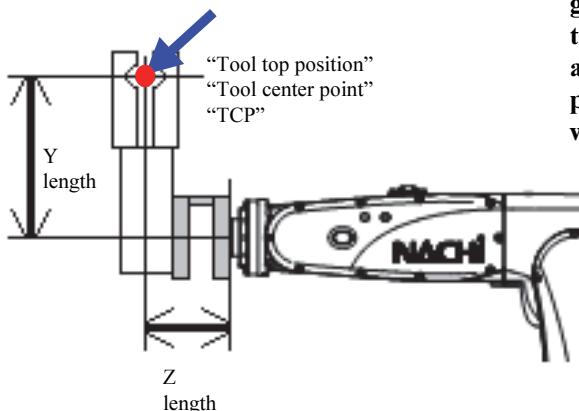
These parameters are necessary to make an adequate acceleration control.



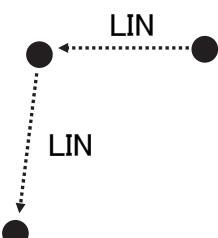
## Tool length (TCP position)



## Tool length (TCP position)



In case of air-control gripper, the center point of the hand should be defined as tool top position. This position moves in linear when interpolation "LIN".



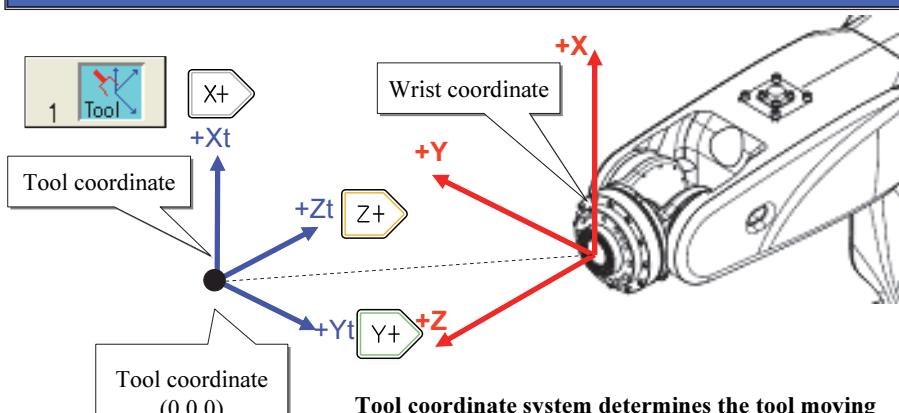
Interpolation movement is controlled based on the tool top position.

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## Tool angle (tool coordinate)



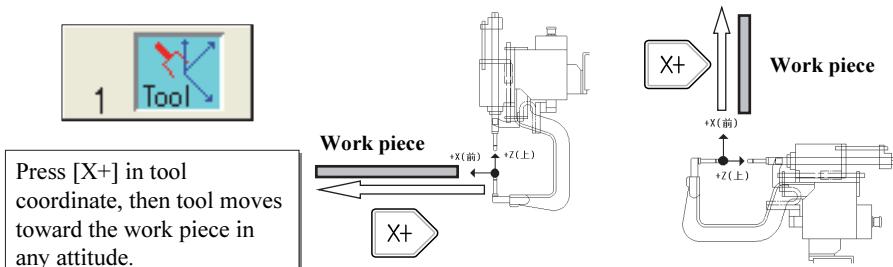
Tool coordinate system determines the tool moving direction.  
This can make teaching much easier even when the shape of work piece is so complicated.

**NACHI**

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## Tool angle

This can make teaching much easier even when the shape of work piece is so complicated because X,Y and Z direction from tool never changes.



**For servo gun system, tool angle setting is absolutely necessary for the correct bending compensation.**

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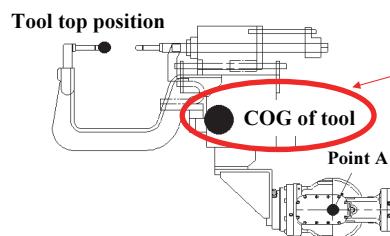
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## Tool weight and COG

Center of gravity

### Tool weight and COG



Correct tool weight and COG position is necessary to make an adequate acceleration control.

Automatic tool weight and COG setting is convenient to get the correct value.

**EXPERT** or higher operator is needed.



If tool weight, COG and inertia are larger than the rated capacity, this may cause to shorten the lifetime of robot.  
In this case, robot is out of guarantee.

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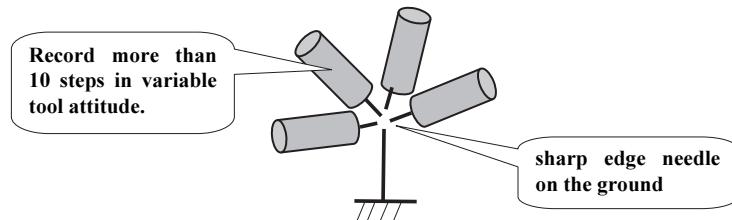
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## Tool length easy setting

### 1 Preparation of measuring program

At first, install the **sharp edge needle** on the ground.  
Then make a program where tool top position is touched the edge in variable tool attitude. Record more than 10 steps (preferred).



- POINT**
- All steps have big different tool angle.
  - All steps are recorded in interpolation ON (LIN).
  - Record TCP position as correct as possible. (needle is preferred.)

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## Tool length easy setting

### 2 Calculation of Tool length by the taught program

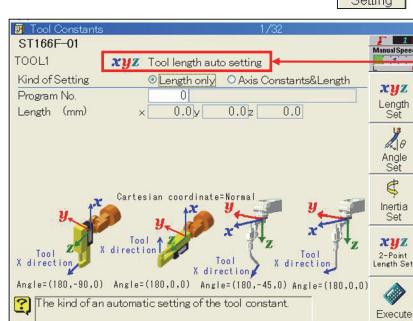


[3 Machine Constant]



[1 Tool Constant]

Press



Confirm the title of "Tool length auto setting"

If another screen was displayed, then press



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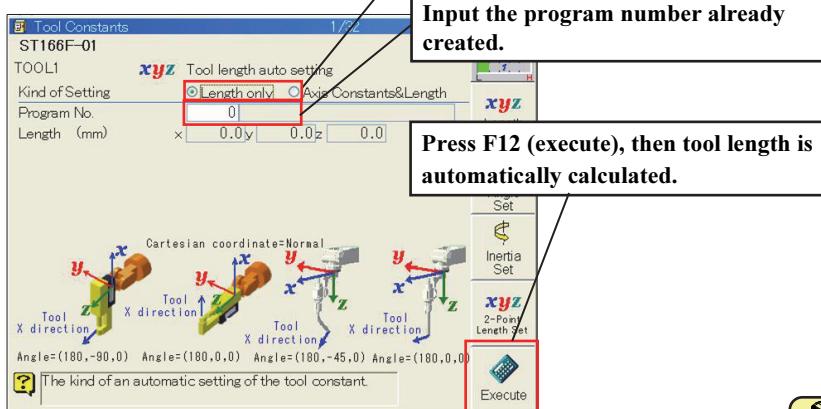
## Tool length easy setting



Choose "Length only"

Input the program number already created.

Press F12 (execute), then tool length is automatically calculated.



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## Tool length easy setting



Result display

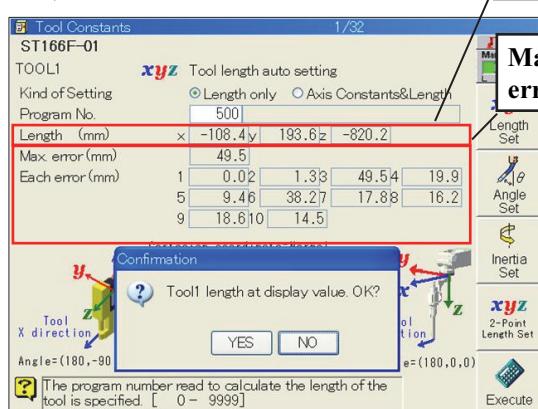
Calculated result of tool length

Maximum error and step error (up to 10 steps)

3

If max. error is big, modify the worst step and try calculation again.

Repeat this work until maximum error becomes satisfied.



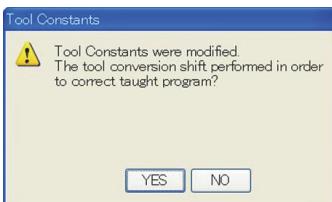
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## Tool length easy setting



**Finally press F12 (Complete)  
to store data in memory.**



If this work was first time, **select “NO”**.

If this work was not first time because tool was transformed or some reason, “YES” can be selected. Then existing programs are converted (joint angle for each step is modified) so that TCP position is to be same position as before.

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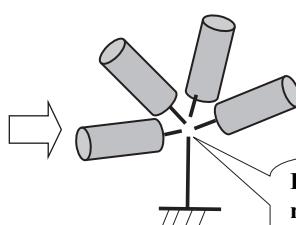
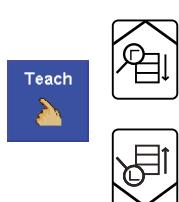


## Tool length easy setting

4

### Confirmation of the result (tool length)

Confirm the calculated tool length value. Select the same program (10 steps program) and execute Check GO.



If tool top position does  
not move between the  
step, set data is correct.

In teach mode, grip enable  
switch and press [Check GO]  
key.

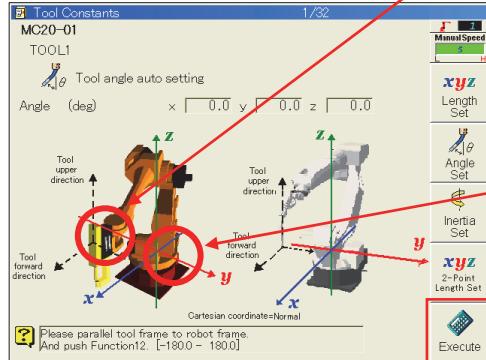
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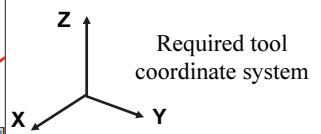


## Tool angle easy setting

Press  at easy setting screen.

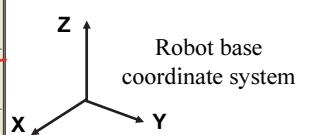


at easy setting screen.



Required tool  
coordinate system

Move the robot manually so  
that two coordinate systems  
seem to be parallel.



Robot base  
coordinate system

Finally press F12 (Execute)  
to store data in memory.



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## Automatic tool weight & COG setting

1

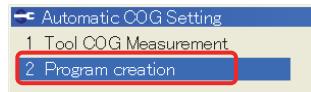
### Preparation of measuring program

Only designating two basement poses. Other steps are automatically created by the controller.

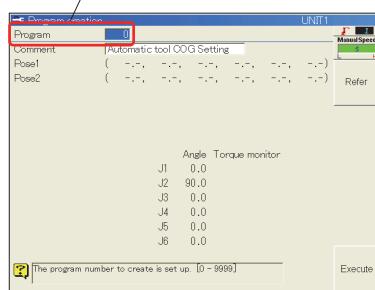
In Teach mode



[19 auto COG setting]



Input the empty program No. This program number  
is created as the auto COG setting program.

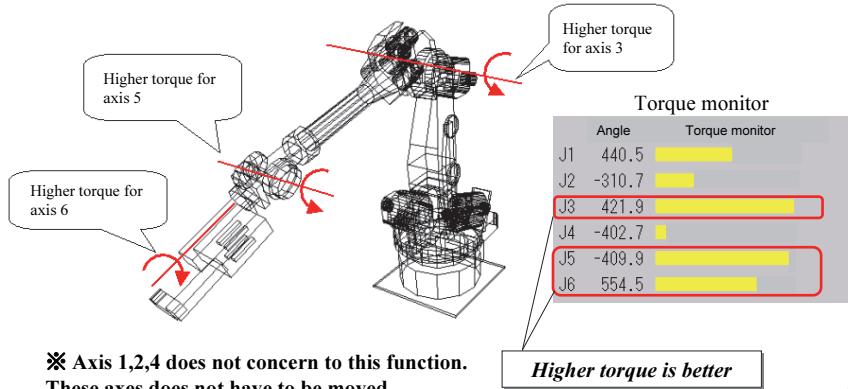


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## Automatic tool weight & COG setting

Record poses as shown below. Torque of axis 3, 5 and 6 had better be high. Watch torque monitor graph in screen.



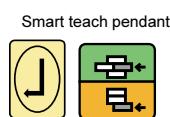
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## Automatic tool weight & COG setting

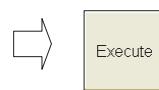
Align cursor at "Pose 1" line



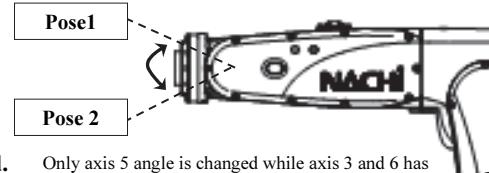
Then its position (pose) is displayed.

Program creation		UNIT1
Program	3	
Comment	Automatic tool COG Setting	
Pose1	( 0.0, 90.0, 0.0, 0.0, 15.0, 90.0)	
Pose2	( 0.0, 90.0, 0.0, 0.0, -17.5, 90.0)	

Record "Pose 2" in same way. But change pose much.



Measuring  
program is created.



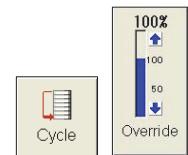
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## Automatic tool weight & COG setting

### 2 Measuring of tool weight and COG.

Change mode to Playback, and select “1 cycle mode” and velocity override 100%.



In Playback mode



[19 auto COG setting]



**Tool COG Measurement**

Program 3 [EX]      UNIT1

Tool No. T TOOL

Tool weight setup  Auto calculation  Sp

Tool setup Tool 1 COG x 0.0 y 0.0 z Mass kg

Servos load setup J3 +1 0.0 x 0.0 y 0.0 J3 -2 0.0 x 0.0 y 0.0

Execution status J1 0.0 J2 90.0 J3 0.0 J4 0.0 J5 0.0 J6 0.0

Angle Torque monitor

Input the created program No. and tool No which length is required.

Select “automatic” when tool weight is unknown.

Input the weight and COG of payload on forearm. If those are unknown, leave these values to 0.

The program number to create is set up. [0 - 9999] Execute

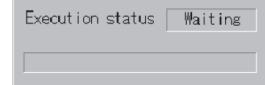


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## Automatic tool weight & COG setting

Press f12 (Execute)

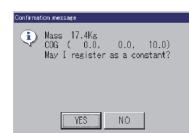


Robot is ready to measure data.

Motor power ON and start



Robot moves slowly and tool weight and COG is calculated.



After that, robot stops and result is displayed on the screen.

Select “YES”. Tool weight and COG is now registered.



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## Tool inertia easy setting

There are 3 method to set the inertia of tool.

### MANUAL CALCULATION

Complicated calculation is necessary by manual using drawing.  
Result may vary because of the human skill.

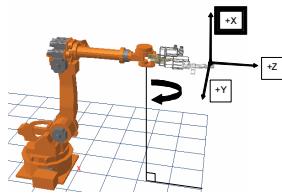
### EASY SETTING (Register the shape of tool)

Just register the shape of tool, then controller can calculate inertia from this data. Although registering work is so easy, result may not be correct if tool has complicated shape.

### AUTOMATIC INERTIA SETTING

Prepare the measuring program and playback it, then controller can calculate inertia same as automatic weight and COG measurement. Result may not be correct if tool was too small (lower than 40% of rated inertia).

Please refer to "Setup manual (FD)"



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**NACHI**  
Robot school

**CFD standard course**

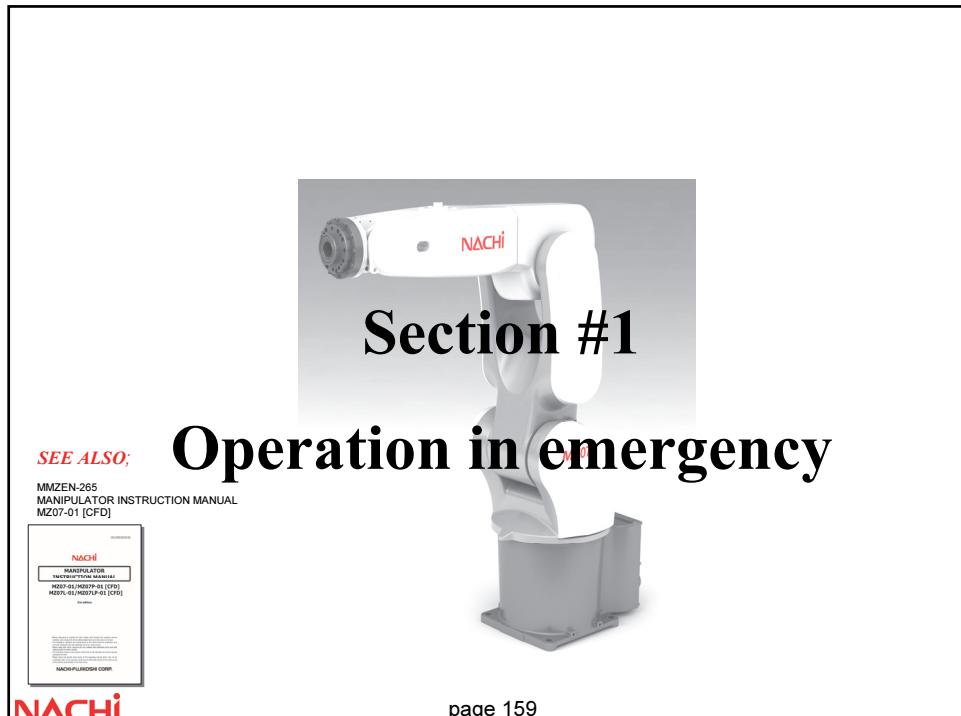
### Maintenance

Section#1: Operation in emergency  
Section#2: Controller  
Section#3: Data backup and restoring  
Section#4: Manipulator

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**NACHI**  
NACHI-FUJIKOSHI CORP.



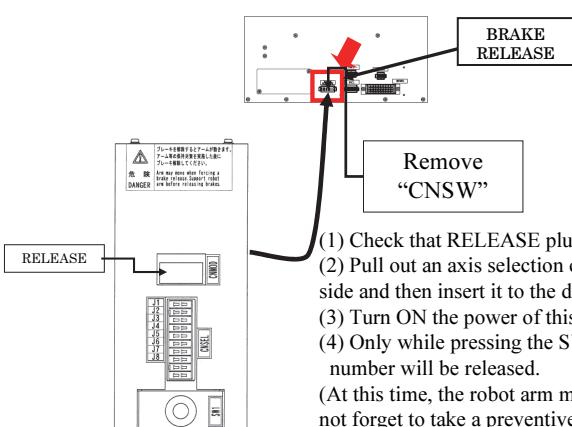
**SEE ALSO:**

MMZEN-265  
MANIPULATOR INSTRUCTION MANUAL  
MZ07-01 [CFD]

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## Brake release switch (option)



- (1) Check that RELEASE plug is in the CNMOD connector.
- (2) Pull out an axis selection connector from the CNSEL bottom side and then insert it to the desired position (axis number).
- (3) Turn ON the power of this controller.
- (4) Only while pressing the SW1, the brake of the selected axis number will be released.  
(At this time, the robot arm may fall down or move fast. Please do not forget to take a preventive measure before pressing the SW1.)
- (5) After finishing the brake release operation, insert the connectors to their original positions. Do not forget to put the jumper plug CNSW to the BRAKE RELEASE on the backside of this controller again.

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## Brake release switch (option)



DANGER



The arm drops or moves forward or backward by the gravity force. Release the brake after taking steps to support arm and any other parts. At first switch back quickly to see the behavior of arm.

Death or serious injury may result if you make contact with the robot or are squeezed between the robot and another part.

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SEE ALSO:

ECFEN-007  
CFD CONTROLLER INSTRUCTION MANUAL  
CONTROLLER MAINTENANCE

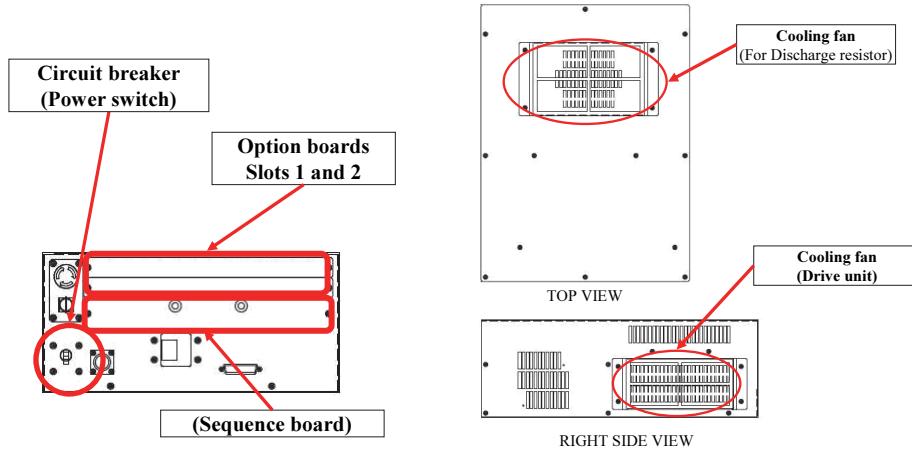


## Section #2 Controller

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NACHI-FUJIKOSHI CORP.

## Function of each parts



## Periodical inspection and maintenance

### ■ Daily Inspection

- Check the functions of pushbutton switches and other operating switches and key sheets of the teach pendant
- Clean up whole of controller (Dirt and dust), and or so
- Check the dirt of the filter on the controller (top side and right side)

### ■ Inspection every 3 months

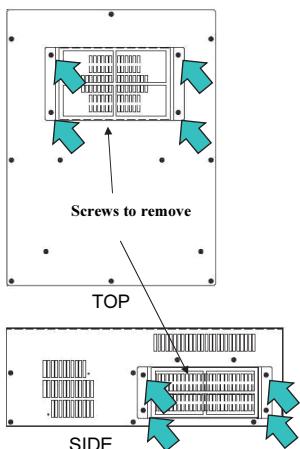
- Check the damage of wire harness (control cables), Teach pendant (T/P) functions cable, loosening of connectors, and or so

### ■ Inspection every 1 year

- Check the Clearance and deformation of packing, lock keys
- Check the unfastened connectors and grounding terminals
- Measure the voltage of primary power, contacts of magnet SW, and or so

Please refer to CFD controller maintenance manual

## Cleaning/changing the filter



- (1) Turn OFF the controller power.
- (2) Remove the screws of the filter cover.
- (3) Clean the dusts on the filter using air blow spray etc. The air blow should be applied from the inside of the filter. If the filter is remarkably dirty, wash it using tepid water or neutrality detergent. If the dirt does not run, replace the filter.
- (4) Re-install the filter. If the filter is still wet, dry it well before the installation.

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*SEE ALSO:*TCFEN-154  
CFD / START UPTFDEN-002  
FD / BASIC OPERATIONS MANUAL

Chapter5

Chapter6



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## File manager

**To select file and copy**

**To see the directory of external memory device**

**To delete unnecessary file**

**To protect important file**

**To verify (compare) two files**

**To initialize external memory device**

**To make backup of whole program and setting parameters.**

**External memory device -> CFD controller; USB memory ("RC Ext. Mem1")**

Refer to the manual "Basic Operation" Chapter 6.

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## File manager

**Basic image of "File Manager"**

**Device selection field**

**Program No. input field**

**File type selection field**

**Folder selection field**

**File directory**

**Upon completion of the necessary settings, press f12 <Execute>**

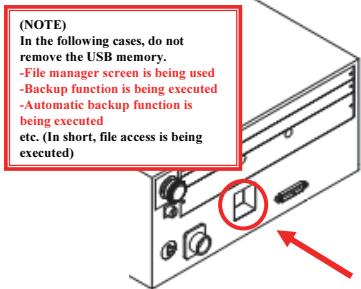
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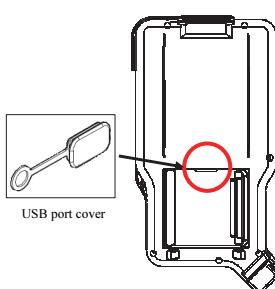
## How to insert USB memory

There are 2 USB ports on the CFD controller

CPU board



Teach pendant



- For backup operation that handle huge amount of files
- Merit is keeping connected.

- Do not have to turn the power OFF for inserting USB memory
- For file copy operation that handle few files
- Do not forget to put the cap after use

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## Initializing of external device

**"USER"** level is enough for this operation



Initialize menu is here

CFD Controller



When initializing USB memory,  
IMPORTANT use USB port on CPU board.

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## Making backup (Smart TP)

**“USER” level is enough for this operation**



Making backup menu is here



## Making backup (Smart TP)

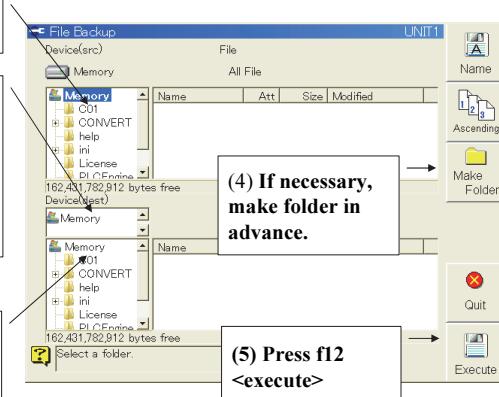
(1) Device (source) is “Memory”

(2) Device (destination) is

RC Ext.memory 1  
... USB port on the front panel

TP Ext.memory  
... USB port on backside of teach pendant

(3) Select target folder of destination device and press [Enter]



New folder such as “NRA2011-2011-11-06-0932” is automatically created.



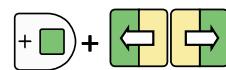
## Checking backup (Smart TP)

**"USER"** level is enough for this operation



Check menu is here

In order to read too long characters such as "NRA2011-2011-11-06-0932", press following keys.



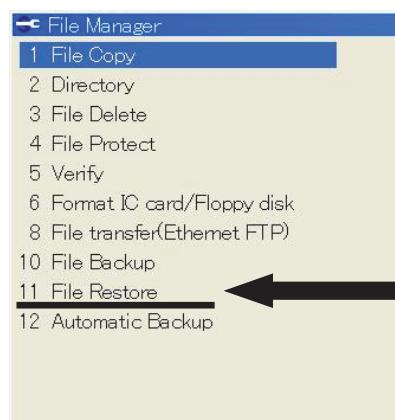
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## Restoring backup (Smart TP)

**EXPERT** or higher operator is needed for this operation



Restoring menu is here

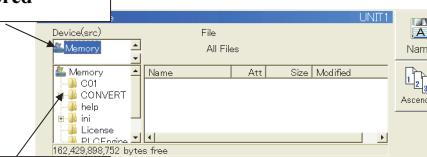
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## Restoring backup (Smart TP)

(1) Device (source) is external device where backup data is stored



(2) Select folder where backup data is stored and press <Enter>.



(3) Device (destination) is "Memory"

(4) Press f12<execute>

(4) Press f12<execute>



(5) Press any key

Shut down (Microsoft)



(6) Upon completion of shut down, turn the power off and ON again



## Restoring backup (Smart TP)

**Property of backup folder must be “Read only”. This property is automatically set in backup operation (manual and automatic).**

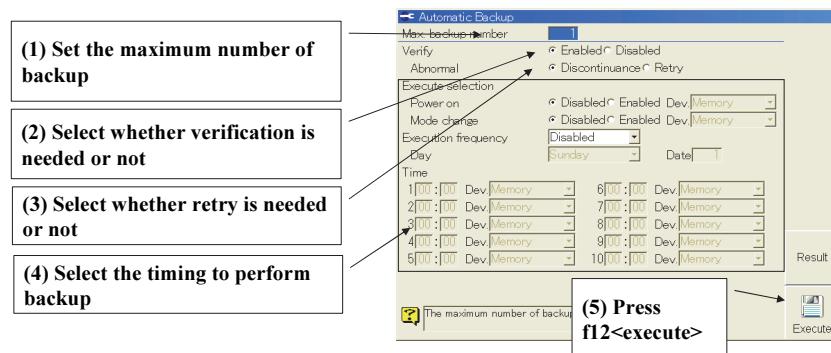


IMPORTANT

If property of backup folder is changed to other than “Read only” by personal computer and or so, this folder can not be selected as the backup source.

## Automatic backup (Smart TP)

Data backup operation can be executed automatically by designating date and time and or so.



Use USB port on the front panel of the CFD controller for automatic backup.

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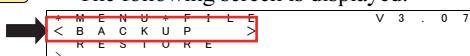
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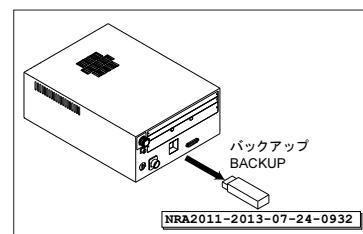
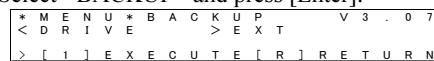
## Making "backup" (Compact TP)

START  
MENU

Press [START/MENU] and select <FILE>. >>The following screen is displayed.

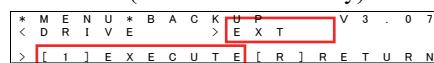


Select <BACKUP> and press [Enter].



NRA2011-2013-07-24-0932

Select <EXT (External USB memory)> for the <DRIVE> and press [1]EXECUTE.



FN  
1

Backup will start. After confirming its completion, press [START/MENU].



START  
MENU



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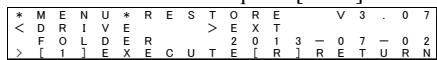
## Restoring “backup” (Compact TP)

**START**  
**MENU**

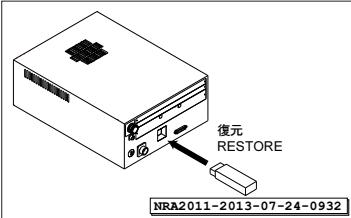
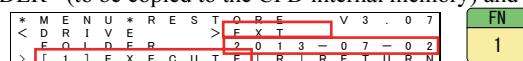
Press [START/MENU] and select <FILE>  
>>The following screen is displayed.



Select <RESTORE> and press [Enter].

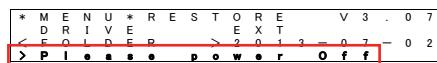


Select <EXT (External USB memory)> for the <DRIVE> and select the desired <FOLDER> (to be copied to the CFD internal memory) and then press [1]EXECUTE.



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“Restore” will start. After confirming its completion, turn OFF and ON the CFD controller.



**FN**  
**1**

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### SEE ALSO:

MMZEN-265  
MANIPULATOR INSTRUCTION MANUAL  
MZ07-01 [CFD]



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## Periodical inspection

### ■ Daily Inspection

- Correct playback position as usual
- Check abnormal heat and sound on motor
- Check if the robot or tool falls down when turning ON/OFF the servo power

### ■ Periodical replacement

- Battery

### ■ Inspection every 3 months

- Clean up the body (remove dust and oil dirt)
- Tension check of the timing belts
- Refasten the fixing major bolts (including tool attaching bolts)
- Check abnormal heat and sound on reduction gear, and so on

### ■ Inspection every 1 year

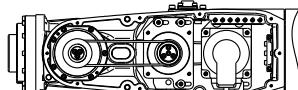
- Check correct functioning of brakes

Please refer to robot maintenance manual (manipulator) for detail.

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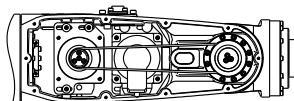
## Periodical inspection : Belts



Initial tension of Axis 6 belt	29 to 40 [N]
SPAN	0.110 [m]
MASS	0.013 [kg/m]

Tension adjustment bolt  
Tension fixing nut  
Axis 3 belt tension measurement position

Initial tension of Axis 3 belt	108 to 122 [N]
SPAN	0.180 [m]
MASS	0.041 [kg/m]



Initial tension of Axis 2 belt	108 to 122 [N]
SPAN	0.120 [m]
MASS	0.041 [kg/m]

Tension adjustment bolt  
Tension fixing nut  
Axis 2 belt tension measurement position

Initial tension of Axis 5 belt	29 to 40 [N]
SPAN	0.179 [m]
MASS	0.013 [kg/m]

**Do not forget to turn OFF the Motors  
when measuring the tension of the belts.**

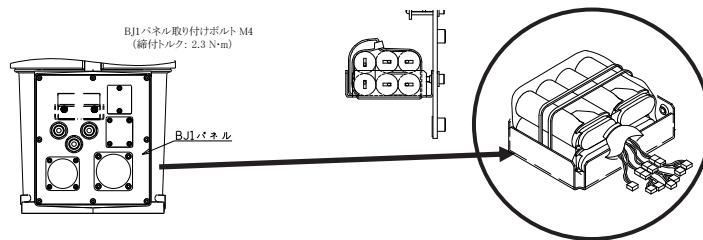
Please refer to robot maintenance manual (manipulator) for detail.

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## Periodical replacement: Battery

Battery is for encoder data backup. If not replaced periodically, robot can not been driven correctly because correct position is never detected.



**Battery must be replaced while keeping main power ON.**

Please refer to robot maintenance manual (manipulator) for detail.

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## Troubleshooting of manipulator

Symptom	Defective Parts	Overload	Displacement	Shaking while in operation	Abnormal deviation	Irregular twitching	Sway when stopped	Malfunction	Abnormal heat generation	Gravity drop of axis
Encoder	○			○	○	○		○		
Brake	○	○					○	○		
Motor	○	○	○	○	○	○	○	○	○	
Reduction Gear	○	○	○					○	○	
Installation plate, Raiser		○	○	○	○					
Tool				○						

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Robot school

**CFD standard course**

**Automatic operation**

Section#1: File protection  
Section#2: Designating how to start the robot

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A white NACHI industrial robotic arm is shown on the left side of the page. The robot has a grey base and a white upper body with red accents. The word "NACHI" is printed on the top of the upper arm, and "M20T" is printed on the wrist. To the right of the robot is the NACHI logo in red, followed by the text "Robot school". Below that is the title "CFD standard course" in bold black font. Underneath that is a blue-bordered box containing the text "Automatic operation". At the bottom of the page, there is descriptive text about sections 1 and 2, and at the very bottom left is the NACHI logo.



SEE ALSO:

TCFEN-154 CFD / START UP      TFDEN-002 FD / BASIC OPERATIONS MANUAL

Chapter5      Chapter6

**Section #1**

**File protection**

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The page features a large image of the NACHI M20T robotic arm on the right. To the left of the arm, the text "Section #1" and "File protection" is displayed in large, bold, black font. Below this, there is a heading "SEE ALSO:" followed by two manual titles: "TCFEN-154 CFD / START UP" and "TFDEN-002 FD / BASIC OPERATIONS MANUAL". Under each title are two chapter numbers: "Chapter5" and "Chapter6". Below these chapter numbers are two small thumbnail images of the respective manuals. The NACHI logo is located at the bottom left of the page.

## File protection

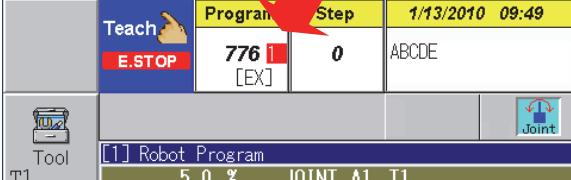
**File Manager**

- 1 File Copy
- 2 Directory
- 3 File Delete
- 4 File Protect
- 5 Verify
- 6 Format IC card
- 10 File Backup

**File Protect**

**This function enables to protect the important files (programs) not to be modified and deleted by miss-operation.**

**This sign indicates “now protected”**

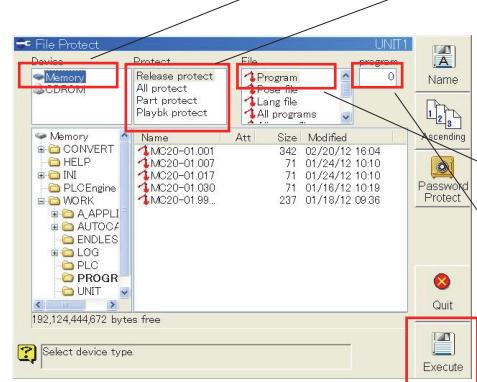


(Shortcut R269 can also perform this operation)

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## File protection

**[4 File Protect]**



**“Memory”**

**“All protect”**  
...Protect the file  
**“Release protect”**  
...Release the protection

**Program**

Input the program number and <Enter>

**Finally press “Execute”**

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**SEE ALSO:**

TFDEN-001  
FD / SETUP MANUAL

TCFEN-154  
CFD / START UP

**Chapter 7**

**Chapter 5**

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MZ07

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## Designating how to start the robot (Smart teach pendant)

Selection of start source and program source  
("Internal" or "External")

Teach Pendant

Host controller or  
Operating console, etc

Start input  
Program No.  
input

Internal

External

Start Prog Con \* Con

Start Prog Ext \* Ext

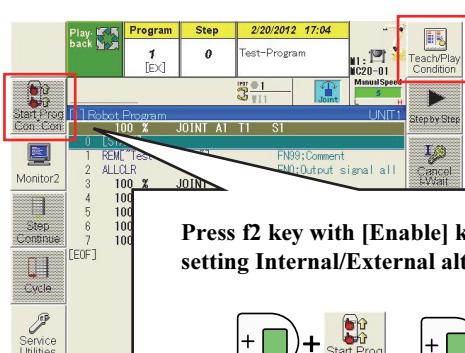
Robot can not be started  
from Teach pendant  
Program can not be selected  
From teach pendant

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## Designating how to start the robot (Smart teach pendant)

Playback mode



Press f7 [Teach/Play Condition] key to open menu where start selection and program selection can be selected individually.

Press f2 key with [Enable] key to change setting Internal/External alternatively.



"Start selection" and "Program selection" are changed at the same time

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## Designating how to start the robot (Compact teach pendant)

Select the "Playback" mode



Internal

**DEL**  
R

**ACC**  
5

**ENTER**

**+ (ON)**  
0

**ENTER**



"Internal" is selected.

External

**DEL**  
R

**ACC**  
5

**ENTER**

**FN**  
1

**ENTER**



"External" is selected.

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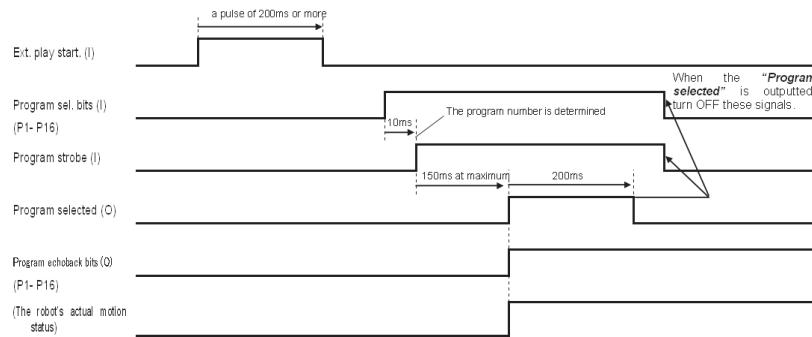


## Designating how to start the robot



**Input the start signal and program selection signal by following to the time chart.**

- In a case in which "Program strobe" is inputted after "Ext.play start"



Time chart example of start selection and program selection both EXTERNAL







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