

NACHI

AX CONTROLLER OPERATING MANUAL

Palletize Function

6th edition

	<ul style="list-style-type: none">■ Before attempting to operate the robot, please read through this operating manual carefully, and comply with all the safety-related items and instructions in the text.■ The installation, operation and maintenance of this robot should be undertaken only by those individuals who have attended one of our robot courses.
	<ul style="list-style-type: none">■ This operating manual must be given without fail to the individuals who will actually be operating the robot.
	<ul style="list-style-type: none">■ Please direct any inquiries about parts of this operating manual which may not be completely clear or any inquiries concerning the after-sale service of this robot to any of the service centers of NRS (Nachi Robotic Systems) listed on the back cover.

NACHI-FUJIKOSHI CORP.

1001, TAXEN-013-006, 001

Before using palletize function

In palletize function, there are 2 types of functions ("Advanced palletize" and "Palletize").

"Advanced palletize function" Pattern setting method, teaching method etc. were improved compared with the conventional palletize function. This function is available in the system software AXV08.09 or after.

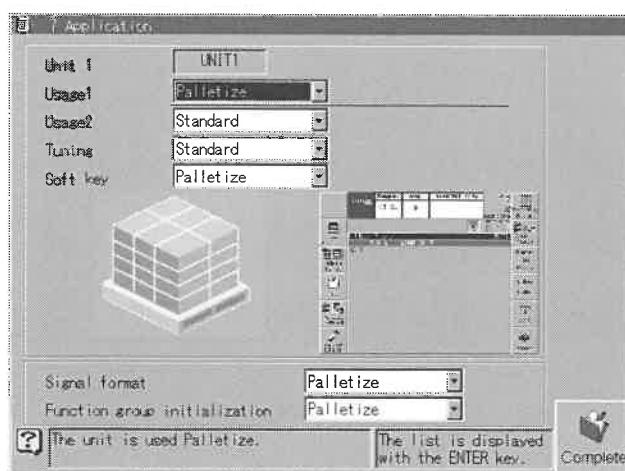
"Palletize function" This is the conventional palletize function.

Because the available application functions (FN) will change depending on the setting, perform a setting in [Constant Setting][12 Format and Configuration][7 Application] screen in advance of teaching operation.

(For this setting, an operator class **EXPERT** or higher is required.)

(1) Advanced palletize function

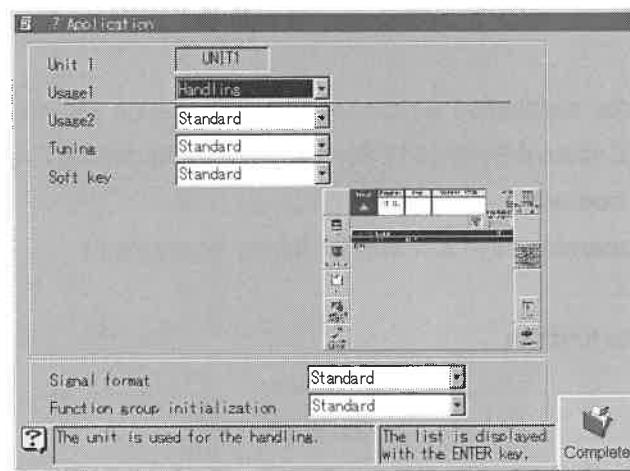
Usage1	: Palletize
Usage2	: Standard
Tuning	: Standard
Soft key	: Palletize
Signal format	: Palletize
Function group initialization	: Palletize



Concerning the details, refer to "**Part1: Advanced palletize function**"

(2) Palletize function

Usage1 : "Handling" or "Standard"
Usage2 : Standard
Tuning : Standard
Soft key : Standard
Signal format : Standard
Function group initialization : Standard



Concerning the details, refer to "**Part2: Palletize function**"

Part 1

Advanced palletize function



The part which is to be read differs depending on the setting of
[Constant Setting][12 Format and Configuration] [7 Application]

In case of "**Palletize**", refer to "Part1:Advanced palletize function"
In case of "**Handling**", refer to "Part2: Palletize function"

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NOTE

Chapter 1 Outline

The term "palletizing" refers to the task involved in arranging objects in an orderly manner. By merely teaching the loading (or unloading) operations for one work-piece and by specifying the number of work-pieces and the way in which they are to be loaded (unloaded) and positioned, it is possible to teach the loading (or unloading) operations for all work-pieces.

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1.1 What the palletize function does

1.1.1 Outline

The term "palletizing" refers to the tasks involved in arranging objects (hereafter referred to as work-pieces) in an orderly manner. The palletize function of the AX controller enables the loading (or unloading) operations for all work-pieces to be easily taught merely by teaching the loading (or unloading) operations for one work-piece and by specifying the number of work-pieces, and the way in which they are to be loaded (or unloaded) and positioned. Conversely, the term "de-palletizing" refers to the tasks involved in unloading in sequence work-pieces which have been loaded.

1.1.2 Frequently used terms

Brief definitions of some of the terms which are used by the palletizing function are given below.

Table 1.1.1 List of terms

Terms	Significance
Work-piece	This term is a generic name of objects that are handled by an industrial robot.
Work information	This refers to defining the information of one work-piece such as length, width and height.
Pallet	The name of an area where work-pieces are lined or the pallet itself.
Layer	The name of the completed shape of palletized work-pieces.
Station	The name where work-piece is delivered.
Pallet coordinate System	Coordinate system defined on the pallet. This is same as the user coordinate system.
Palletize pattern	This refers to specifying the regulation of whole of layer that consists of following data. - Work information - Grasping offset - Layer pattern - Plane pattern
Grasping offset	This refers to defining the offset between the rotating center of gripper (tool top axis) and the center of grasped work-piece.
Layer pattern	This refers to defining the plane pattern for each plane.
Plane pattern	This refers to defining the work-piece arrangement of one plane.
Palletize number	The number to identify the palletize pattern.
Palletize register	An internal variable that manages the palletizing work.
Palletize counter	Work-piece counter number to be executed currently in the palletizing work. This is efficient to know the progress of the palletizing work. Palletize counter consists of following data. - Layer counter - Work counter
Layer counter	Layer number to be executed currently in the palletizing work.
Work counter	Work-piece number to be executed currently in the palletizing work.
De-palletize	This refers to executing opposite operation of the palletizing.
Simultaneous palletizing	This refers to executing more than one palletizing task at the same time. (When one palletizing task ends, the next one begins.)
Multiple palletizing	This refers to executing another palletizing task while a palletizing task is already being performed. It involves adding each palletizing shift amount and performing the shift operations.

Approach	This is the robot moving to be closing to the pallet with slant direction in order to avoid the interference with the already loaded work-piece and to make small clearance between the already loaded work-piece.
Shift	This is the robot moving temporary to the position where is different from the taught position without modifying the data recorded in the step. In palletizing, taught position is shifted according to the information of palletize pattern to execute loading (unloading) whole of work-piece.

1.1.3 Performance

Table 1.1.2 Specifications and performance of palletizing function

Terms	Significance
Palletize pattern	<ul style="list-style-type: none"> • Up to 100 patterns can be registered (using palletizing numbers 1 to 100), shared by the unit • Work-pieces can be loaded up to 50 layers
Grasping offset	<ul style="list-style-type: none"> • Up to 4 can be registered per 1 palletize pattern
Plane pattern	<ul style="list-style-type: none"> • Up to 8 can be registered per 1 palletize pattern
Number of work-piece	<ul style="list-style-type: none"> • Up to 99 can be registered per 1 plane pattern
Pallet (coordinate system)	<ul style="list-style-type: none"> • Up to 100 can be registered, shared by the unit
Number of simultaneous palletizing operations	<ul style="list-style-type: none"> • Up to 32 palletizing operations can be executed at the same time • The status of these operations while they are being executed can be monitored by the palletizing monitor
Number of multiple palletizing operations	<ul style="list-style-type: none"> • Up to 8 multiple operation can be executed
Shift function	Normal shift functions (FN58 and others) are available except the palletizing function (started from PALLET3). When these functions are executed, shift amount is calculated by the palletizing function at first, and then by the shift functions.

1.2 Task stages from teaching to operation

This section describes the work flow up to the stage where the robot executes the palletizing (or de-palletizing) task.

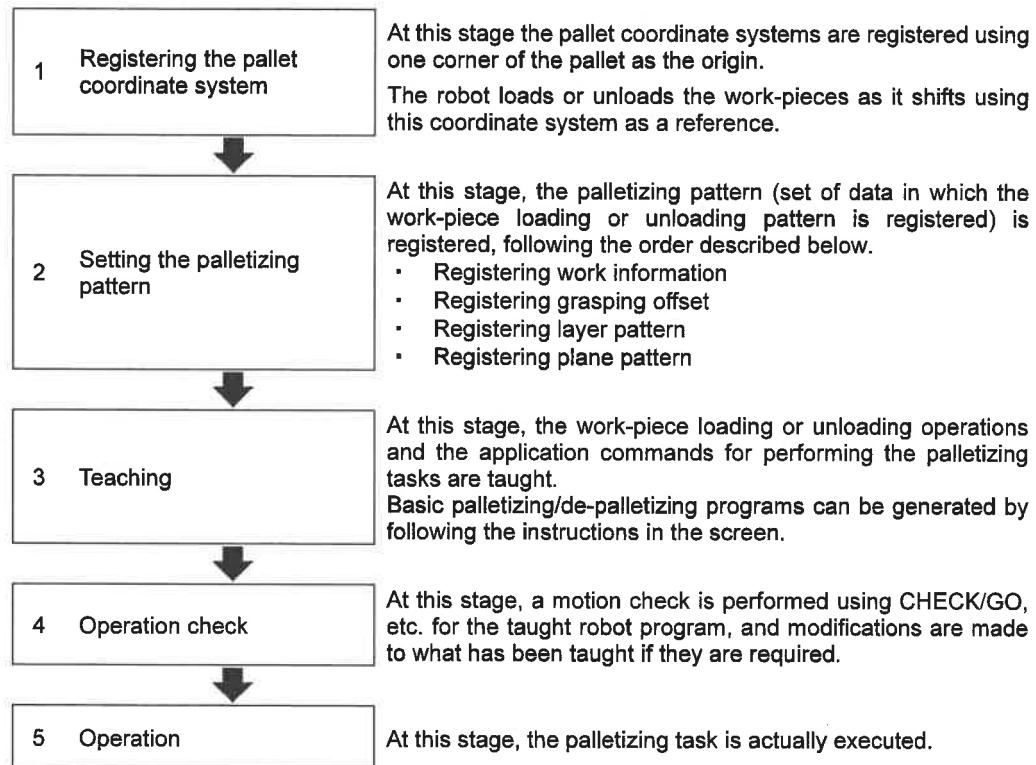
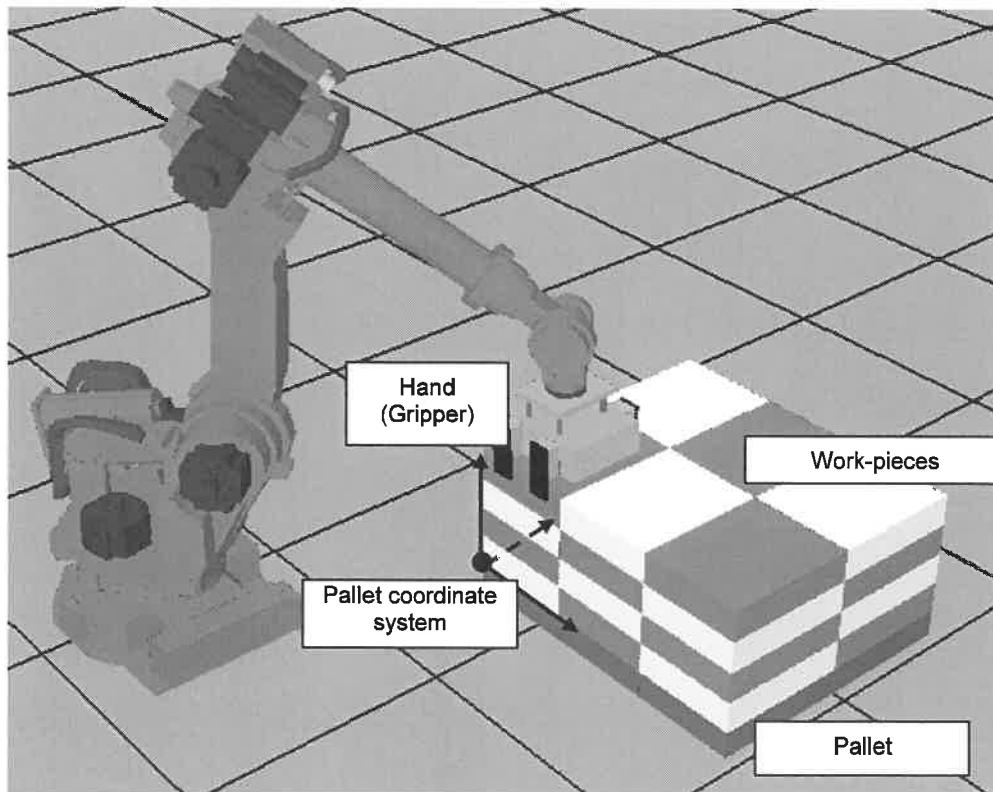


Fig. 1.2.1 Tasks from teaching to operation



1.2.1 Registering the pallet coordinate systems

Because the palletize motion is generated using shift motion based on the respective pallet coordinate system, it is necessary to register those pallet coordinate systems in advance.

Register the pallet coordinate system regarding its corner point as the origin of the coordinate system.

The registration work for the pallet coordinate system can be done in Palletize constant [1 Register pallet].

For details, refer to Chapter 3.

1.2.2 Registering palletize pattern

"Palletize pattern" refers to the set of data in which the work-piece loading and unloading patterns have been registered.

The registration of palletize pattern can be done in Palletize constant [2 Register pattern]. Follow the instructions in the screen to set the required parameters. Select a pattern from the ready-made patterns ("interlock" or "pin hole") in the layer pattern setting screen. Or, it is also possible to set up the position of all the work-pieces one by one.

For details, refer to Chapter 4.

1.2.3 Teaching

To use the palletize function, use the application commands (FN functions).

Basic programs can be generated in Palletize constant [3 Program creation]. And, it is also possible to modify the basic items of the generated program in this setting menu.

How to generate the program is described in Chapter 5.

Concerning the procedure to modify the program is mentioned in Section 5.3.6.

Application commands (FN functions) to having the robot make complicated palletize motion are also available. It is possible to display or set the value of the register (internal variable) that is being used in the actual palletize function.

If you want to refer to the palletize register, See Section 6.3.1.

If you want to set the palletize register, See Section 6.3.2.

1.2.4 Motion check and initiating operation

Check the generated robot program using CHECK GO or 1-step playback, ascertain whether the robot will be performing the desired operations and, if necessary, modify what has been taught. Upon completion of the motion check of the robot program, actually play back the program in the 1-cycle or continuous playback mode.

If it is necessary to modify the palletize counter while the checking operation, refer to Section 6.2.2.

It is possible to place the robot TCP (Tool Center Point) to the position of the loading position of certain work-piece to reflect the position to the palletize pattern. (This is called as "Palletize direct modification")

If it is necessary to execute a direct modification for palletize pattern, refer to Section 6.2.3.

How to display the number of the current work-piece that is being palletized now in the monitor window is described in Chapter 7.

NOTE

Chapter 2 Setup

This chapter describes the setup procedure for using the palletizing function.

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2.1 Setup

"Advanced palletize function" is an option software. If this function is not installed at the timing of shipping, this function is not available. And, it is also necessary to set the application type to "**Palletize**".



To select "**Palletize**" as application type, a software version of AXV8.09 or after is required. And, this function cannot be used with "**Simple palletizing / complex palletizing**" included in "**Handling**" application type at the same time.

2.1.1 Tool constants

The position of the Tool Center Point (TCP) is defined by the tool length and the tool angle. The robot moves referring to the TCP position and the "Grip point" for the palletizing motion is set using the TCP as a reference point.

It is not necessary to modify the setting for this TCP (leave the initial setting of "flange center" as it is). But if the setting is changed, the motion locus of the robot is generated by referring to the new (modified) TCP position.

Tool mass(weight)

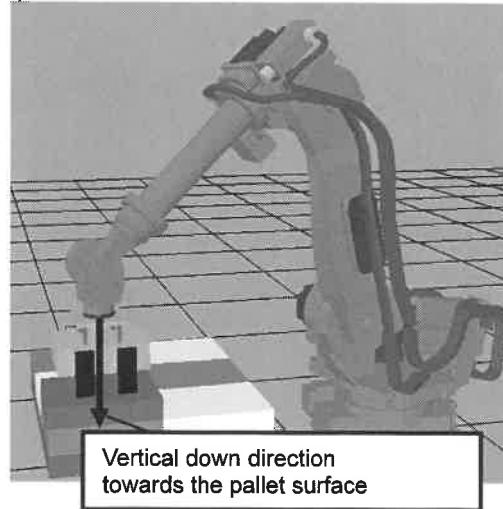
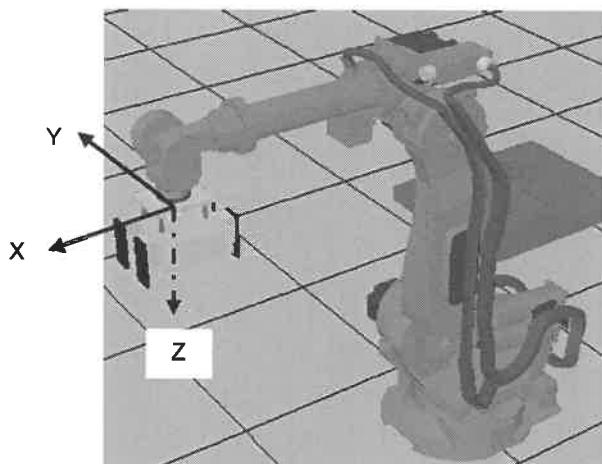
In the "tool mass" setting value, the mass of the work-piece that is to be held by the tool (gripper) must be included.

Tool angle

The direction of the tool coordinate system is determined referring to the tool angle setting. The offset position that is set from the "Grip point" is calculated following this tool coordinate system.

Determine the tool angle setting so that the vertical down direction towards the pallet surface and the +Z direction of the tool coordinate system become the same when the hand (gripper) that is holding the work-piece is placing the work-piece onto the pallet.

But, because those directions are the same when using initial setting, it is not necessary to modify the setting. (See the following figures)



Initial setting of the TCP and the Tool coordinate system Setting of the tool angle

If a program generating function is used (Refer to Section 5.3):

Steps that use both Tool 1 (T1) and Tool 2(T2) will be generated.

In case of Tool 1 (T1), it is supposed that the work-piece is being held. (Heavier)

In case of Tool 2 (T2), it is supposed that the work-piece is not being held. (Lighter)

Therefore,

For T1, the tool mass setting value and the "C of G" setting values must include both of the gripper and the work-piece. For T2, the tool mass setting value and the "C of G" setting values must include only gripper itself. The tool length setting for T1 and T2 should be the same.

2.1.2 Shift amount limit

In this palletize function, the robot will move to the position that is different from the originally recorded position by referring to the shift amount that is calculated via the arrangement information of the work-piece of the palletize pattern. At this time, if an extremely large value is stored in the shift amount because of some reasons, the robot will extremely deviate from a position that is intended.

To avoid this, the shift amount limit value can be set in advance.

The limit value can be modified in [Constant Setting] [3 Machine Constants] [6 Shift amount limit] menu.



CAUTION

If the shift amount limit values are changed, the robot may make unexpected motion.
If the limit values are changed, do not forget to confirm the motion of the program that is to be played back.

2.2 Input/output signals dedicated to palletize function

Signals to modify the palletize register via external devices can be set.

2.2.1 Input signal

To reset the palletize counter, the signals of "Palletize reset" and "Palletize No." are required. And, to reset the palletize counter, the signals of "Palletize preset", "Palletize No.", "Layer No." and "Work No." are required.



- 1 Enter [4 Signals][1 Palletize inputs] menu from the "Palletize Constant" key.
Or, enter [Constant Setting][6 Signals][1 Palletize inputs] menu.
>> The following setting screen will appear.

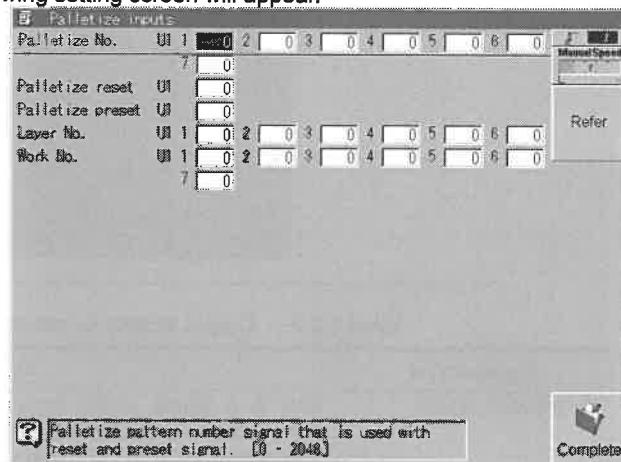


Table 2.2.1 Input signals for palletize function

Signal name	Function	Remark
Palletize No. (7 bits)	This signal is used to designate the "palletize number". This signal is used in a combination with other signals. The palletize number (from 1 to 100) is to be designated via 7-bit binary signals.	Per UNIT
Palletize reset	This is a signal to reset the palletize counter of a designated palletize number at the timing of rising edge of the signal. However, if the target palletize number is "being played back" and "being executed", this signal is ignored. When the reset process is normally executed, "Reset ACK signal" is outputted.	Per UNIT
Palletize preset	This is a trigger signal to pre-set the palletize counters ("Layer No." and the "Work No.") for the designated palletize number at the timing of rising edge of the signal.	Per UNIT
Layer No. (6 bits)	These are signals to designate the layer number for the palletize counter pre-set. Input the layer number (from 1 to 50) via 6-bits binary signals.	Per UNIT
Work No. (7 bits)	These are signals to designate the work-piece number for the palletize counter pre-set. Input the work-piece number (from 1 to 99) via 7-bits binary signals.	Per UNIT

2.2.2 Output signals



- 1 Enter [6 Signals][2 Palletize outputs] menu from the "Palletize Constant" key.
Or, enter [Constant Setting][6 Signals][2 Palletize outputs] menu.
>> The following setting screen will appear.

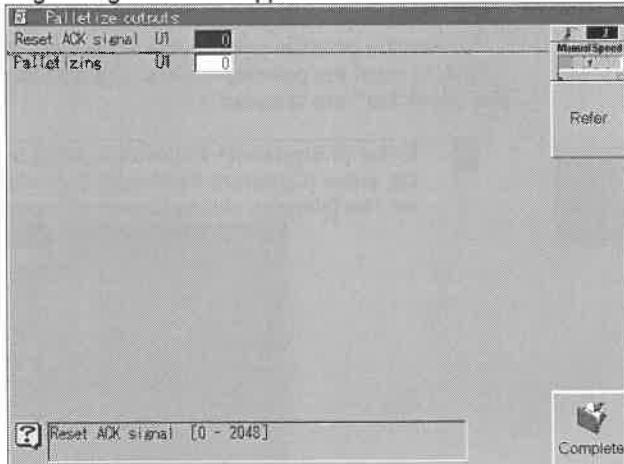


Table 2.2.2 Output signals for palletize function

Signal name	Function	Remark
Reset ACK signal	This is a signal which turns ON when "Palletize reset" input signals is received and the palletize counter is reset. This signal will turn OFF when the next palletize starts.	Per UNIT
Palletizing (available for the software of AXV08.011 and after)	This is a signal which turns ON while in palletizing. This signal will turn OFF when palletizing is completed or palletize reset is executed. If more than 2 palletizing are executed at the same time, this signal will turn OFF when all of them is completed or reset is executed.	Per UNIT

2.2.3 Palletize counter value binary output signals

This is a set of output signals that outputs a "palletize counter value" via binary signals in real-time.

It is not necessary to assign these signals before use. To use this signal, please designate a set of general output signals as a parameter of "FN249 palletize start" function.

Concerning "FN249 Palletize start", refer to the section 5.2.1.

2.2.4 Palletize completion signal

This is an output signal that shows the completion of a pattern of the palletize / de-palletize process. Please use this signal to confirm that the loading/unloading is completed normally.

It is not necessary to assign this signal before use. To use this signal, please designate one general output signal as a parameter of "FN250 palletize end" function.

Concerning "FN250 Palletize end", refer to the section 5.2.1.



In case of default setting, the all general signals will be turned OFF when the first step of a program is executed. If it is necessary to keep the condition of these signal mentioned above even if the first step of a program is executed, please change the setting of "5 Output signals in step 0" to "Hold" in [Constant Setting][6 Signals][1 Signal condition] menu.

2.3 Palletizing condition

This item is available for the software of AXV08.011 and after.

Here conditions for palletizing function are set.



- 1 Enter [5 Condition] menu from the "Palletize Constant" key.
 Or, enter [Constant Setting][40 Palletize constant][5 Condition]
 >> The following setting screen will appear.

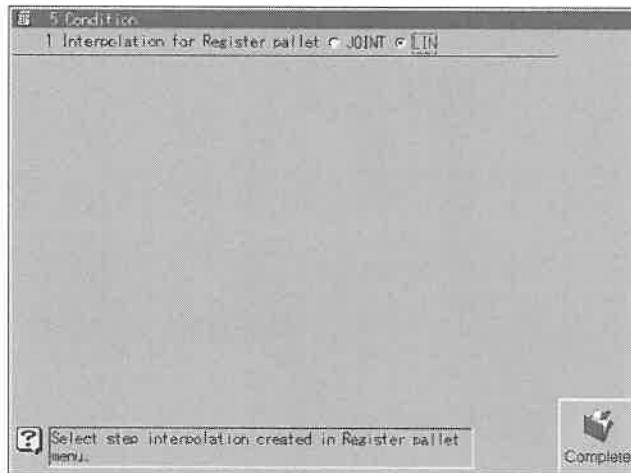


Table 2.3.1 Setting items in [5 Condition]

Item	Factory setting	Input range	Description
Interpolation for Register pallet	LIN	JOINT/LIN	This is to selecting the interpolation type when registering the pallet.

NOTE

Chapter 3 Registration of a pallet

In this chapter, how to register a pallet (coordinate system) that is used as a reference coordinate system for the palletize motion is described.

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3.1 Registration of a pallet coordinate system

A pallet coordinate system that is treated as "a reference coordinate system" for palletize motion is registered here.

3.1.1 Outline

The palletize motion is made using shift motion based on the position and the direction of the pallet. Therefore, it is necessary to register a pallet coordinate system in advance.

The corner edge of a pallet which is used for loading the work-pieces is to be registered as an origin of the coordinate system.

The pallet (coordinate system) can be defined via 3 points listed below;

- (1) An origin (The corner point of the pallet)
- (2) A point to define the +X direction of the coordinate system in combination with the origin.
- (3) A point to define the +Y direction of the coordinate system in combination with the origin.

The registration work is performed in [1 Register pallet] screen. And, it is also possible to register a pallet using a program that has 3 points described in the above explanation.

The important point is, (not the position of the origin) the direction of each axis. The direction of each axis determines the positions of the work-pieces that will be loaded / unloaded.

Please be sure to record the points of (2) and (3) aligning them precisely seeing from the origin point so that each direction of +X and +Y axis becomes precise.

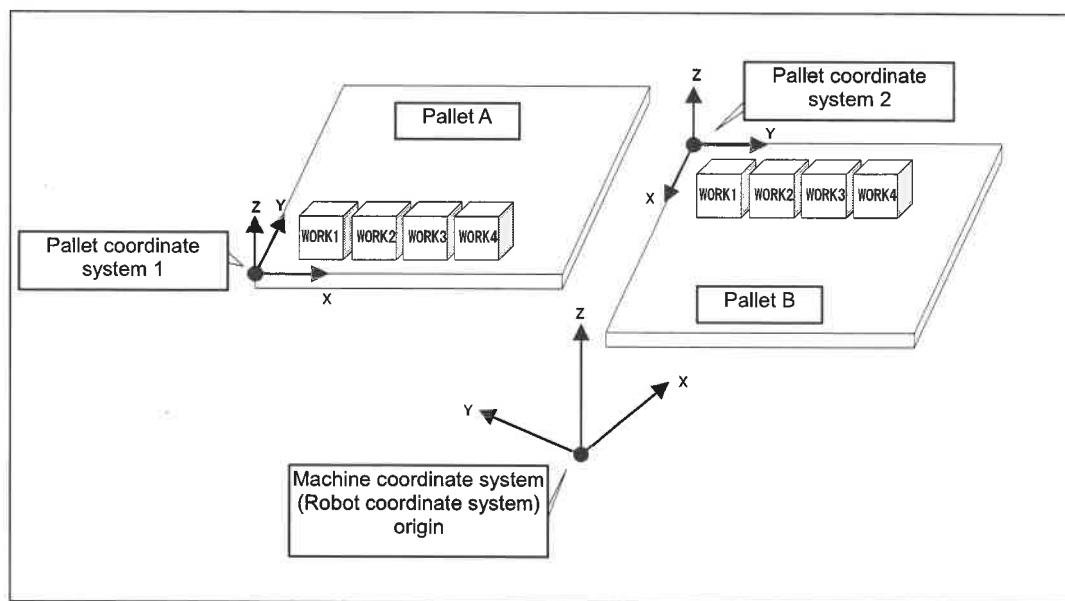


Fig 3.1.1 Pallet coordinate system

3.1.2 Registering a pallet coordinate system

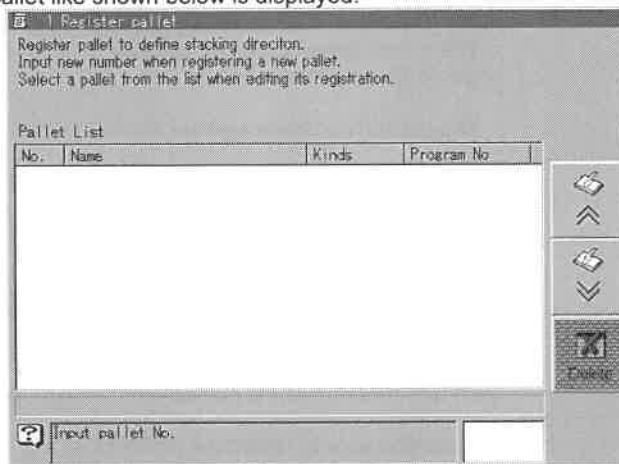
A registration of a pallet (coordinate system) using 3 points should be done here. When registering the pallet, a program will be generated.

- 1 Select Teach mode.



- 2 Select [1 Register pallet] from "Palletize Constant".

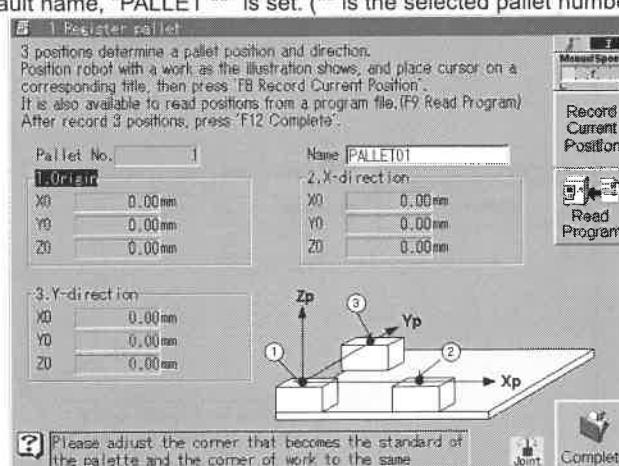
>>A list of pallet like shown below is displayed.



- 3 Enter a pallet number to register and press [Enter] key.

>>Pallet registration screen will be displayed.

>>As a default name, "PALLET **" is set. (** is the selected pallet number)



<INTERP/COORD>



<Manual speed.>

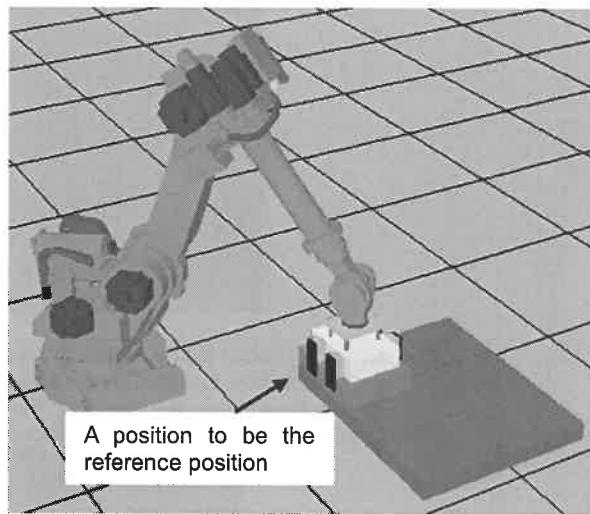


- 4 Make the robot hold a work-piece and move it to the position to be reference position on the pallet. For example, align the edges of the pallet and the work-piece.**

At this time,

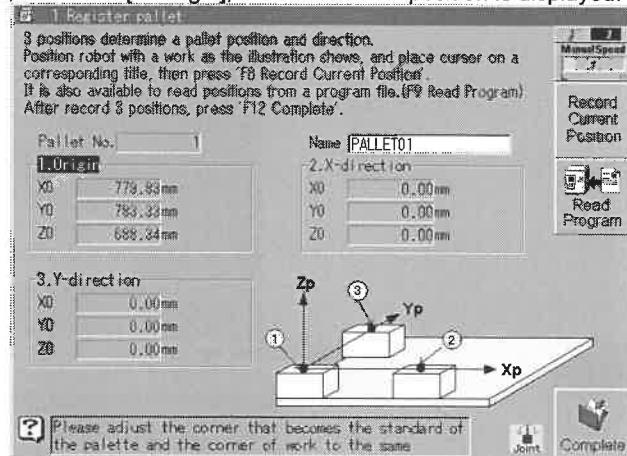
-Manual operation speed of the robot can be change with F7 key.

-Manual operation coordinate system can be changed with [INTERP/COORD.] key.

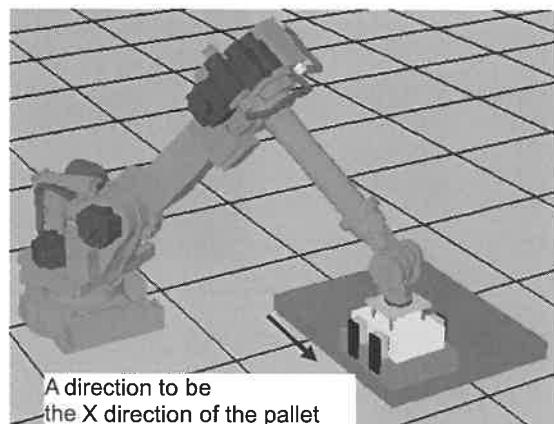


Record
Current
Position

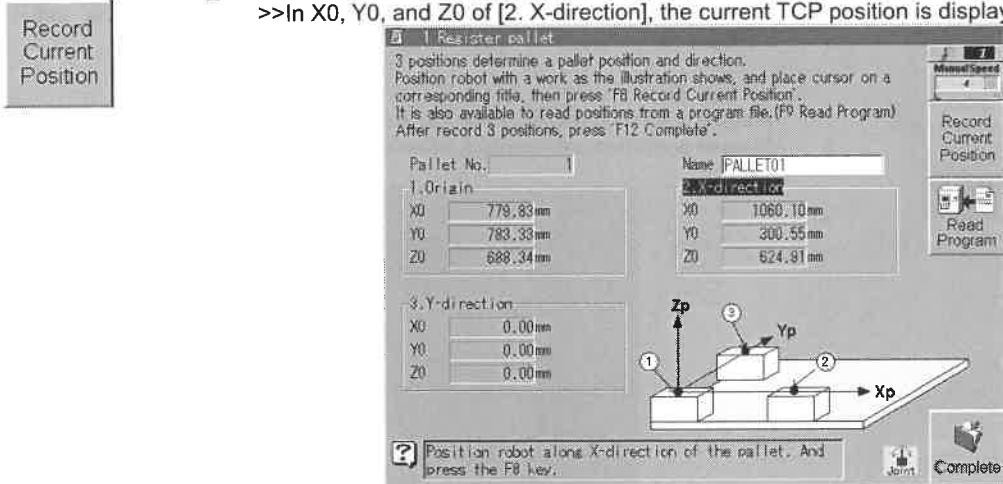
- 5 Move the cursor to [1.Origin] and press <f8:Record Current Position>**
>>In X0, Y0, and Z0 of [1. Origin], the current TCP position is displayed.



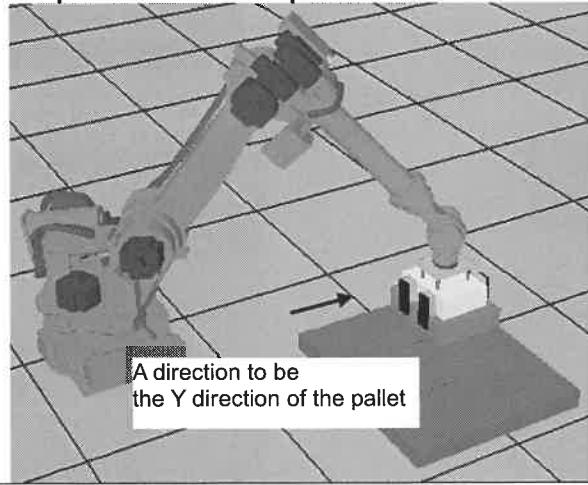
- 6 Move the robot that is holding the work-piece towards the direction that is to be the X direction of the pallet. At this time, keep the angle of the work-piece against the pallet. And, align the edge of the work-piece and that of the pallet.**



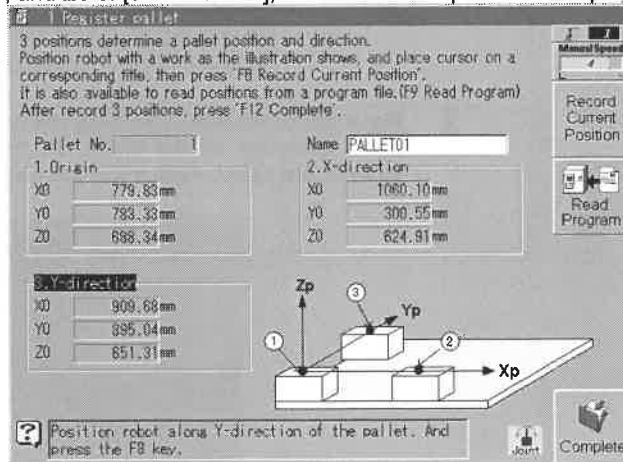
- 7 Move the cursor to [2. X-direction] and press <f8:Record Current Position>**
 >>In X0, Y0, and Z0 of [2. X-direction], the current TCP position is displayed.



- 8 Move the robot that is holding the work-piece towards the direction that is to be the Y direction against the position that is registered at [1. Origin]**
 At this time, keep the angle of the work-piece against the pallet. And, align the edge of the work-piece and that of the pallet.



- 9 Move the cursor to [3. Y-direction] and press <f8:Record Current Position>**
 >>In X0, Y0, and Z0 of [3. Y-direction], the current TCP position is displayed.

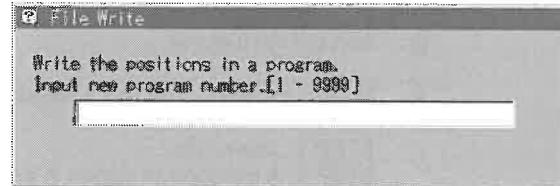




10 Press <f12 Complete> key.

>>A following message window will be displayed.

This window is for designating the number of the program in which the information of the coordinate system is recorded. In the designated program, the 3 positions (= 3 steps) will be recorded.



11 Input the program number for recording 3 positions and press [Enter] key.

>>Now the pallet coordinate system is saved.



The program generated when registering the pallet coordinate system does not have an influence on the motion of the palletize function. But the program is necessary when modifying the pallet coordinate system after registering the pallet coordinate system.

3.1.3 Registering a pallet coordinate system (by a pre-recorded program)

It is also possible to register a pallet coordinate system using a pre-recorded program that has 3 positions for the reference point.

1 Select Teach mode.

2 Make a program that has 3 steps like shown below.

STEP 1: The origin

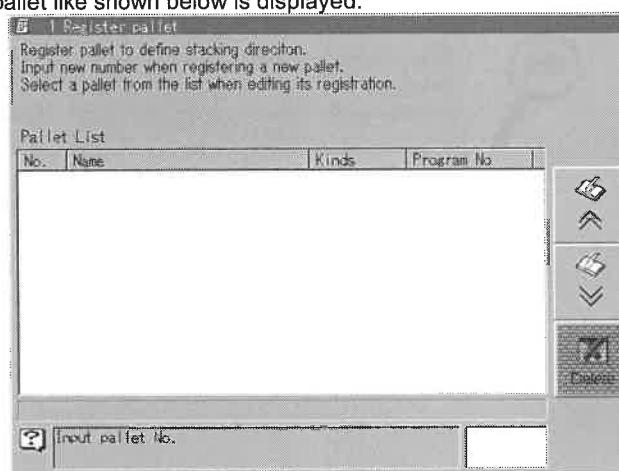
STEP 2: A position to define X direction with the origin (STEP1)

STEP 3: A position to define Y direction with the origin (STEP1)

(In these steps, the tool number must be the same.)

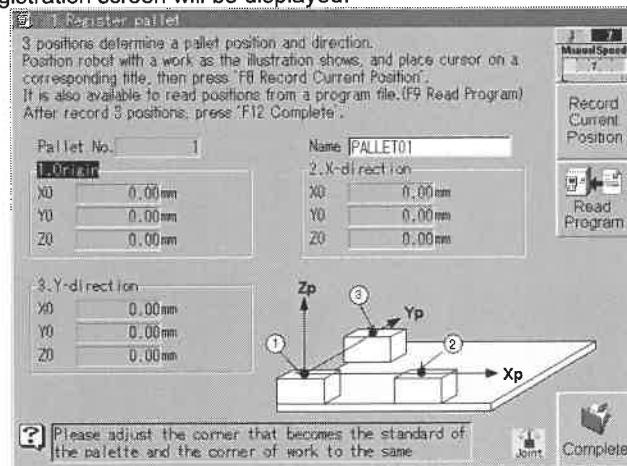
3 Select [1 Register pallet] from "Palletize Constant".

>>A list of pallet like shown below is displayed.



4 Enter a pallet number to register and press [Enter] key.

>>Pallet registration screen will be displayed.





5 Press <f9:Read Program> key.

>>A list of program like shown below is displayed.

Program No.	No. of Steps	Comment
1-ST168-02.001	5	PALLET
1-ST168-02.002	2	

PALLET

Please push "Enter" after selecting the program.

6 Select the desired program and press [Enter] key.

>> The selected program is loaded.

1 Register pallet

3 positions determine a pallet position and direction.
Position robot with a work as the illustration shows, and place cursor on a corresponding title, then press 'F8 Record Current Position'.
It is also available to read positions from a program file.(F9 Read Program)
After record 3 positions, press T12 'Complete'.

Pallet No.	2	Name	PALLET
1.Origin		2.X-direction	
X0	779.33mm	X0	1060.10mm
Y0	793.33mm	Y0	300.55mm
Z0	688.34mm	Z0	624.91mm

3.Y-direction			
X0	909.68mm	X0	1060.10mm
Y0	895.04mm	Y0	300.55mm
Z0	651.31mm	Z0	624.91mm

Position robot with a work at a corner of pallet as the origin. And press the F8 key.

Joint Complete

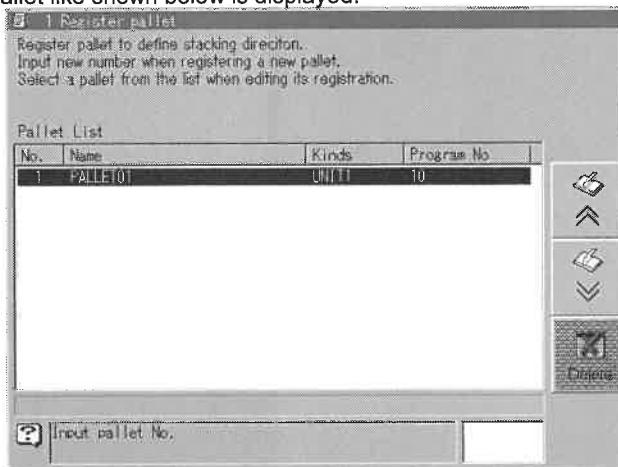
3.1.4 Modifying the pallet

In the pallet list screen, it is possible to modify a pallet by selecting one pallet from the list.

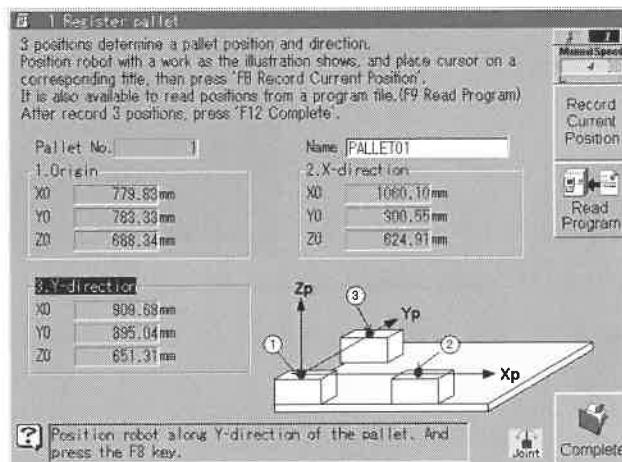
- 1 Select Teach mode.



- 2 Select [1 Register pallet] from "Palletize Constant".
 >>A list of pallet like shown below is displayed.



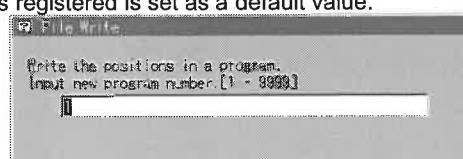
- 3 Set the cursor to the desired Pallet and press [Enter] key.
 >>The coordinates of the 3 points (X0, Y0, Z0) are displayed in the [1 Register Pallet] screen.



- 4 Select the point that you want to modify and press <f8 Record Current Position>.
 >>The current position of the TCP is overwritten to (X0, Y0, Z0) of the selected point instead of the original values.



- 5 Press <f12 Complete> key.
 >>A message like shown below will be displayed.
 >>In the edit box, a program number in which the coordinates information was stored when the pallet was registered is set as a default value.



- 6 Input the program number for saving the pallet data and press [Enter] key.
 >>Now the pallet coordinate system is saved.

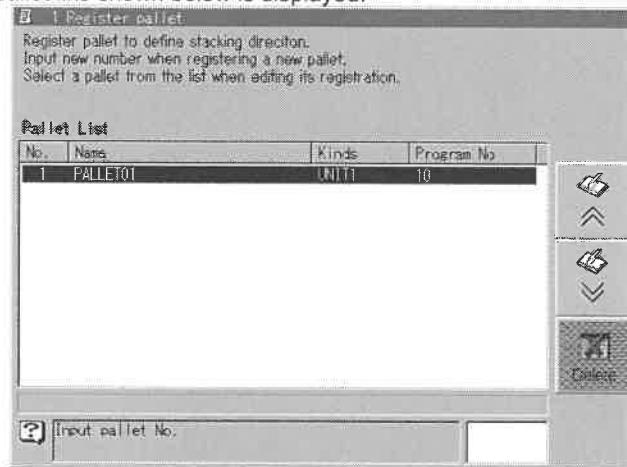
3.1.5 Deleting the pallet

A pallet coordinate system defined previously can be deleted using a pallet list screen.

- 1 Select Teach mode.



- 2 Select [1 Register pallet] from "Palletize Constant".
 >>A list of pallet like shown below is displayed.



- 3 Select one pallet in the list and press [Enable] + <f11 Delete>. A following confirmation message window will be displayed.



- 4 If [OK] is selected, the pallet will be deleted.
 If [CANCEL] is selected, the pallet will not be deleted and the screen will return to the list screen.
 (Even if a pallet is deleted, the program that has the coordinate information will not be deleted.)



CAUTION

When deleting a pallet, please confirm that the pallet is not used in any palletize pattern. If a palletize pattern that uses a pallet which does not exist is used, an error will occur and the robot will stop when executing palletize function.

NOTE

Chapter 4 Registration of a palletize pattern

This chapter describes how to set-up a palletize pattern.

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4.1 Outline

4.1.1 Registration procedures

The registration of a palletize pattern is done by the following procedure.

The procedure is a continuous sequence. So it is not possible to execute only 1 step of them one by one. In the respective screen, press <f10 : Next> key after setting the parameters. And, if it is necessary to return to the previous screen, press <F9:Back> key.

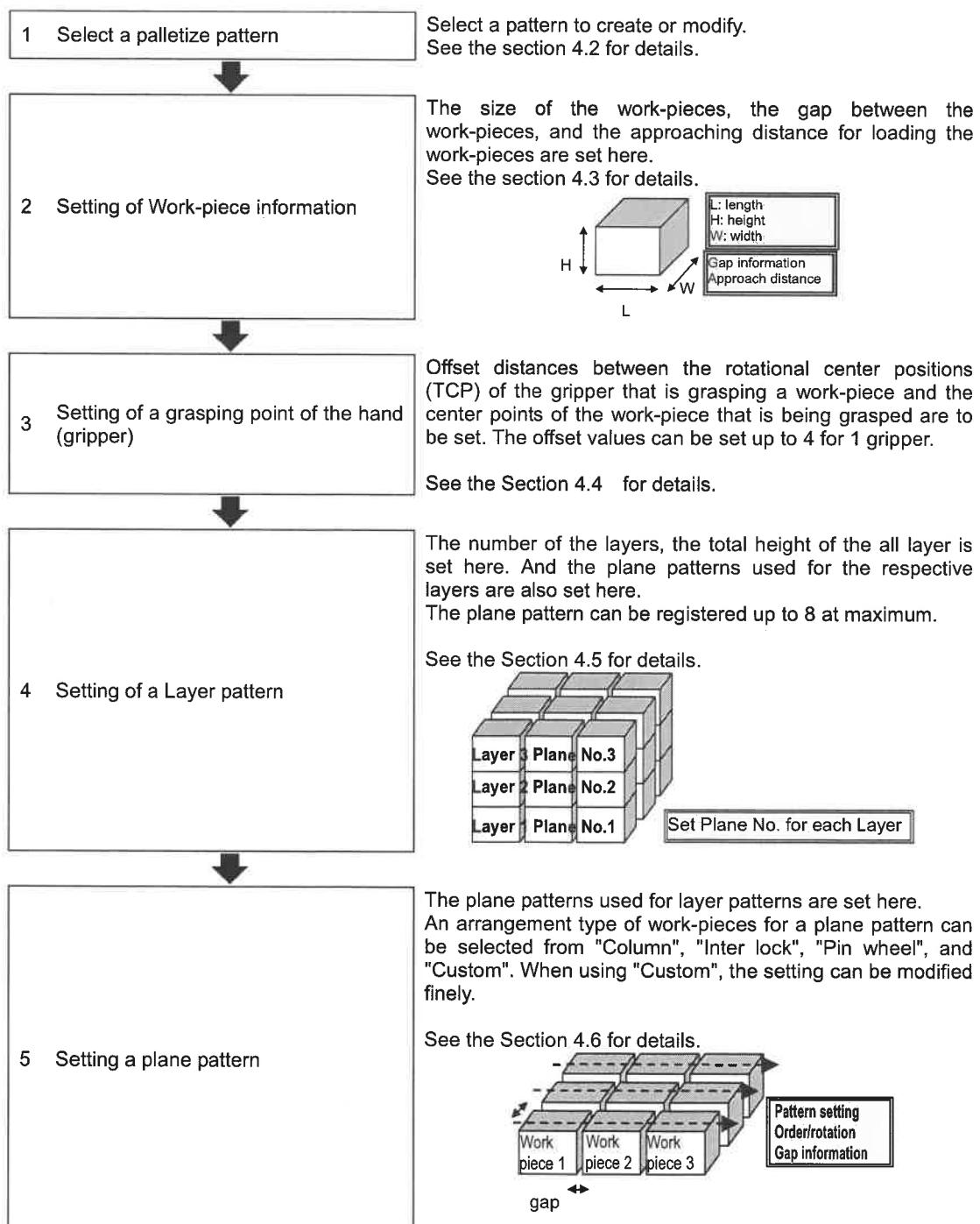


Fig. 4.1.1-1 Setting procedure for a palletize pattern

It is possible to define the palletize patterns up to 100 at maximum. The contents that were set will be stored to the palletize data file "Ac00Pltz.CON".

4.2 Selecting a palletize pattern (to create/modify)

Select a palletize pattern to newly create or to modify from a list.

In the palletize pattern list screen, the following operations are available.

- Create a new pattern / Modify a pattern
- Export a palletize pattern to a file.
- Import a palletize pattern from a file
- Copy a palletize pattern
- Delete a palletize pattern

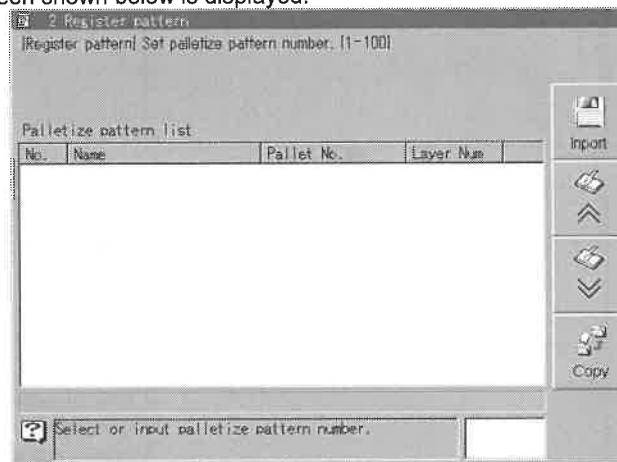
4.2.1 Selecting a palletize pattern

1 Select Teach mode.



2 Select [2 Register pattern] from "Palletize Constant".

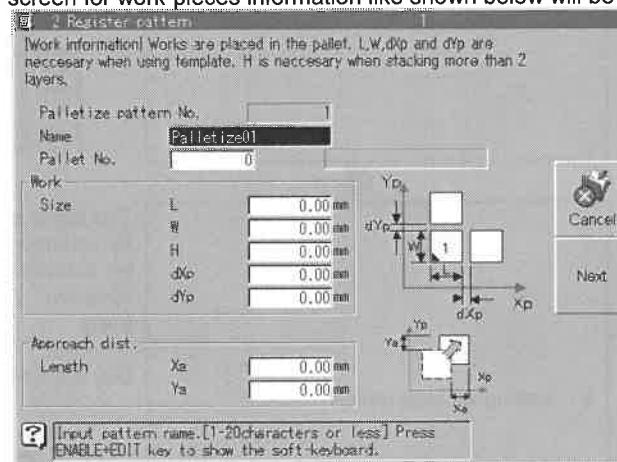
>>A list screen shown below is displayed.



3 Input a number to register and then press [Enter].

To modify a pattern, select the desired pattern using cursor key and then press [Enter].

>>A setting screen for work-pieces information like shown below will be displayed.

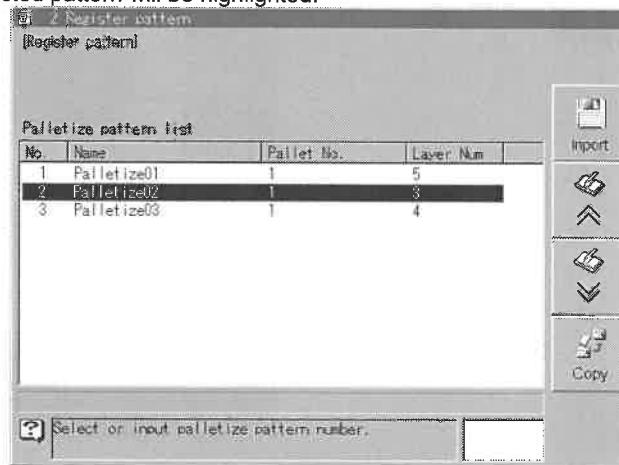


To proceed with "Setting the Work-piece information", refer to the section 4.3 .

4.2.2 Exporting a palletize pattern to a file

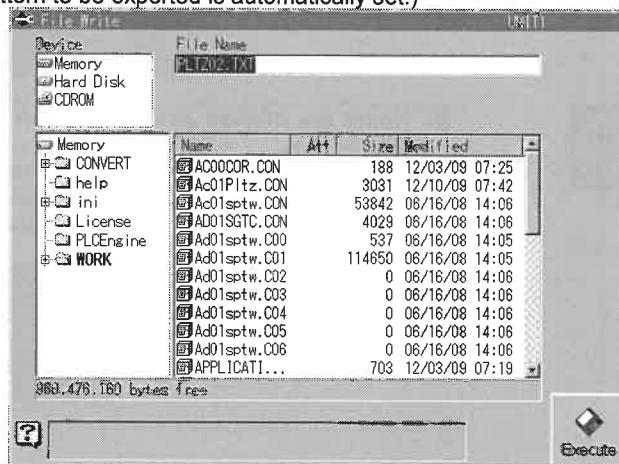
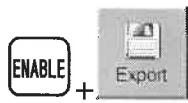
It is possible to export a palletize pattern to a file to use the same pattern for other robots.

- Select a pattern to export in the list screen.**
 >>The selected pattern will be highlighted.



- Press <Enable> + <f8 Export> in the list screen.**

>>A following export screen will be displayed.
 >>The file name "PLTZ**.TXT" is set as default. (For "**", the number of the palletize pattern to be exported is automatically set.)



- Select a folder to save the file and then press <f12 Execute> key.**

>>If the export process is finished normally, the screen will return to the pattern list screen.

To change the file name, select the "File Name" edit box and then press [Enable] + [EDIT] key to display a software keyboard screen.

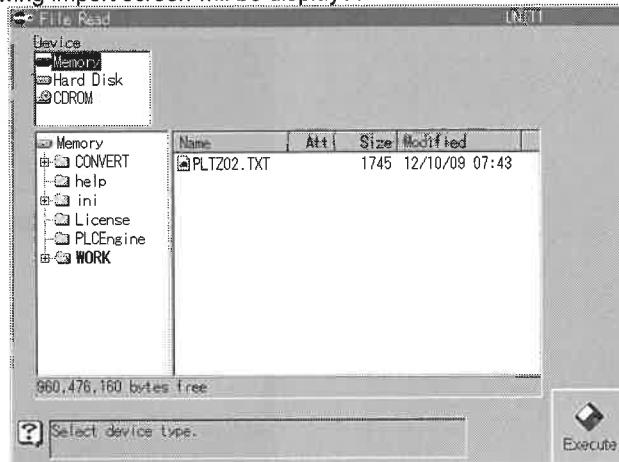


When changing the export file name, do not change the part of ".TXT". If this part is changed, it becomes impossible to read the file from the robot controller.

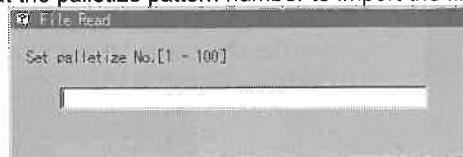
4.2.3 Importing a palletize pattern from a file

It is possible to import a palletize pattern from a file exported from other robots.

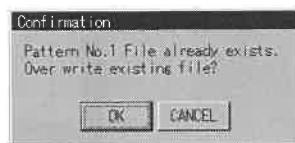
- 1 Press <f8 Import> key in the list screen.**
 >>The following import screen will be displayed.



- 2 Select a file and press <f12 Execute> key.**
 >>A window to input the palletize pattern number to import the file will be displayed.



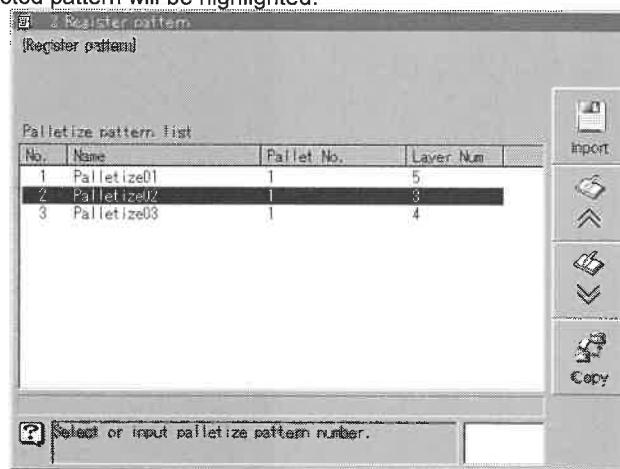
- 3 Input the desired palletize pattern number to import the file and then press [Enter] key.**
 >>The palletize pattern in the file is read and stored to the designated number of the palletize pattern and the pattern is displayed in the list.
 >>If a number which is already exist is inputted, a confirmation message will be displayed.



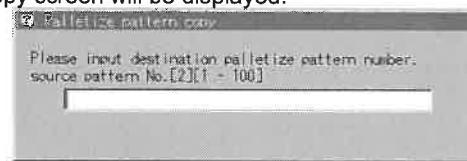
4.2.4 Copying a palletize pattern

A palletize pattern in the list can be copied to the different number.

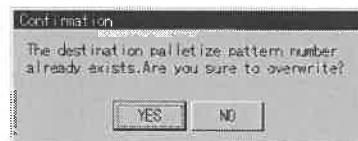
- 1 Select a pattern to copy in the list screen.**
 >>The selected pattern will be highlighted.



- 2 Press <f11 copy> key.**
 >>The following copy screen will be displayed.



- 3 Input the destination number for copy and press [Enter].**
 >>The pattern data is copied to the designated palletize pattern number and the pattern is added to the list.
 >>If a number which is already exist is inputted, a confirmation message will be displayed.

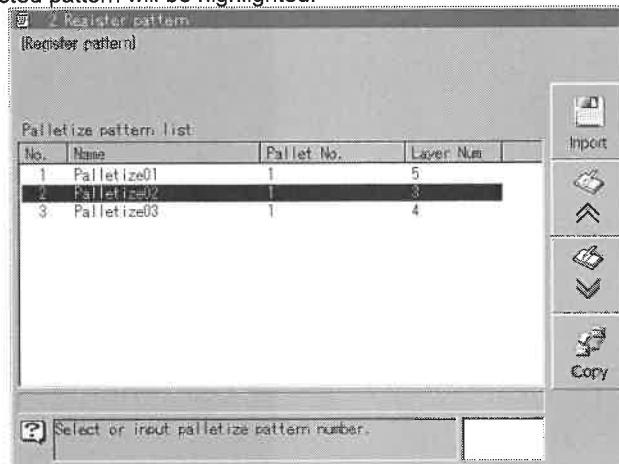


4.2.5 Deleting a palletize pattern

A palletize pattern in the list can be deleted.

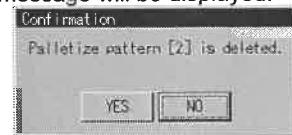
1 Select one pattern to delete.

>>The selected pattern will be highlighted.



2 Press [Enable] + <f11 Delete>

>>A following confirmation message will be displayed.



3 To delete the file, select [YES] and press [Enter].

>>The pattern is deleted and disappears from the list.

4.3 Setting the work-piece information

The size of the work-pieces, the gap between the work-pieces, and the approaching distance for loading the work-pieces are set here.

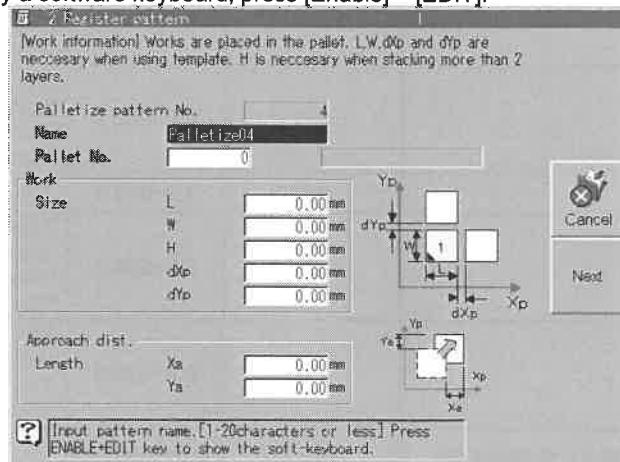


IMPORTANT

The Work-piece's size L/W and the gap dXp/dYp are necessary in the plane pattern setting only when using "Column", "Inter lock", or "Pin wheel". When using "Custom", these parameters are not referred.

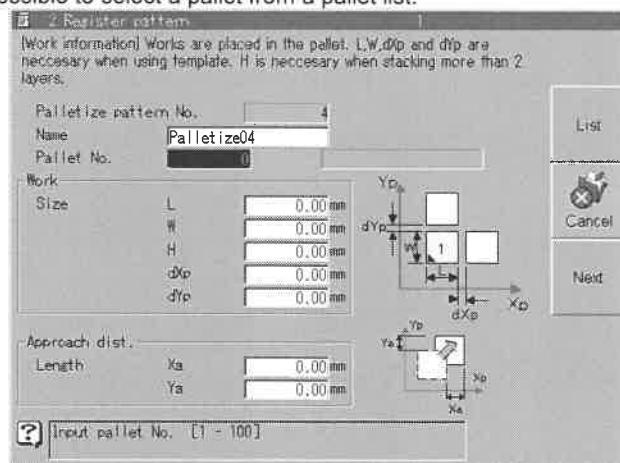
1 Input the palletize pattern's Name.

>>To display a software keyboard, press [Enable] + [EDIT].



2 Input the "Pallet No."

>>When the cursor is placed on the "Pallet No.", <f8 List> key appears and it becomes possible to select a pallet from a pallet list.



3 Input the parameters in the "Work".

4 Input the "Approach distance".

Concerning the "Approach", refer to the section 5.1.3

5 After setting each data, press <f10 Next> key.

>>The next screen "[Grasping offset]" will be displayed.
Concerning "[Grasping offset]", refer to the Section 4.4

Next

Table 4.3.1 Setting parameters in [Work information] screen

Item	Initial value	Range	Description
Palletize pattern No.	---	----	The palletize pattern number selected in the list is displayed. This value cannot be changed.
Name	Palletize01	20 letters or less	Name of the pattern.
Pallet No.	1	1~100	Select a pallet which is treated as a reference coordinate system for shift motion. When the cursor is set here, <f8 List> key will appear and it becomes possible to select a pallet from the list.
Work size L	0.0	0.0~999.9	The length (along the X-direction) of the 1st work-piece when it is placed on the pallet. This value is used when the plane pattern setting is "Column", "Inter lock", or "Pin wheel".
W	0.0	0.0~999.9	The length (along the Y-direction) of the 1st work-piece when it is placed on the pallet. This value is used when the plane pattern setting is "Column", "Inter lock", or "Pin wheel".
H	0.0	0.0~999.9	The height of one work-piece.
dXp	0.0	0.0~999.9	The gap (distance) between the work-pieces in X-direction of a pallet. This value is used when the plane pattern setting is "Column", "Inter lock", or "Pin wheel".
dYp	0.0	0.0~999.9	The gap (distance) between the work-pieces in Y-direction of a pallet. This value is used when the plane pattern setting is "Column", "Inter lock", or "Pin wheel".
Approach distance Xa	0.0	0.0~9999.9	Input the X-direction distance for an approach motion based on the <u>pallet coordinate system</u> .
Ya	0.0	0.0~9999.9	Input the Y-direction distance for an approach motion based on the <u>pallet coordinate system</u> .

4.4 Registration of a grasping offset

Offset distances between the rotational center position (TCP) of the gripper that is grasping a work-piece and the center point of the work-piece that is being grasped should be set.

If this setting is incorrect, the work-pieces that are rotated will not be placed correctly.

The setting of "Grasping position" can be registered up to 4 at maximum. When grasping 2 or more work-pieces by a gripper unit and placing those work-pieces one by one, the playback should be done by switching the setting of Grasping positions.

Two input methods for the setting operation are available; (1) automatic calculation using 2 position data and (2) manual (direct) input.

How to calculate automatically using 2 postures

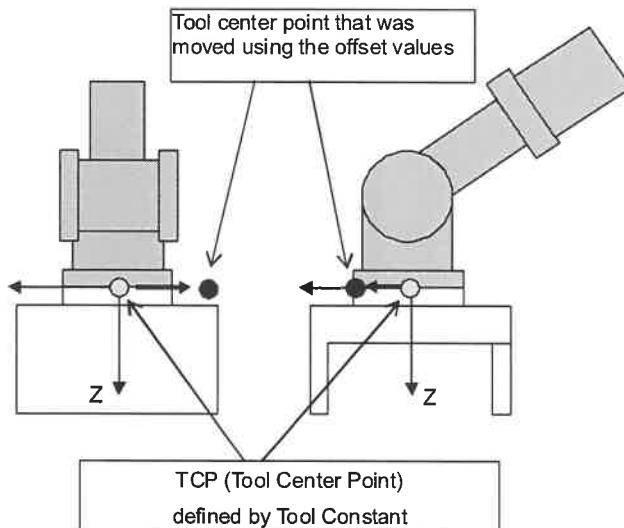
1 Register a reference position

Hold a work-piece with the gripper unit and then place the work-piece on the reference position and register the position. This operation should be done at the corner point of the pallet.

2 Register a position (180[deg] rotation)

Rotate the work-piece around the reference position (180 degrees) and then place the work-piece on the same reference position. And then register the position.

The offset is automatically calculated by pressing "Next" or "Addition" key.

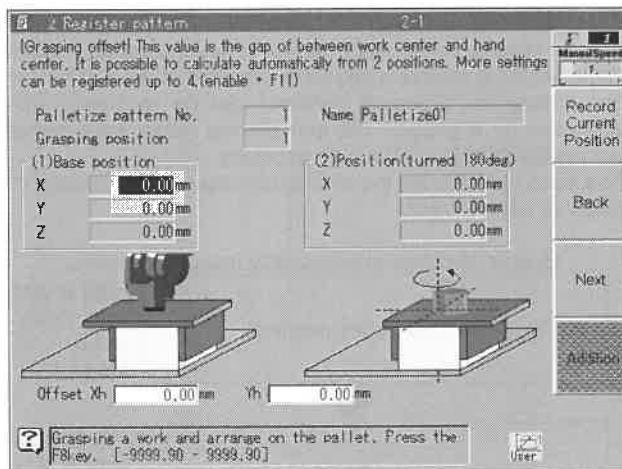


When FN376 (Palletize select grasp position) is executed, the offset value selected via the parameter is added to the current TCP position. By this operation, the rotation center of the tool can be changed from the original TCP to the work-piece center.

Fig. 4.2.5-1 Overview of the Grasping position of the work-piece

4.4.1 Calculating the grasping position automatically

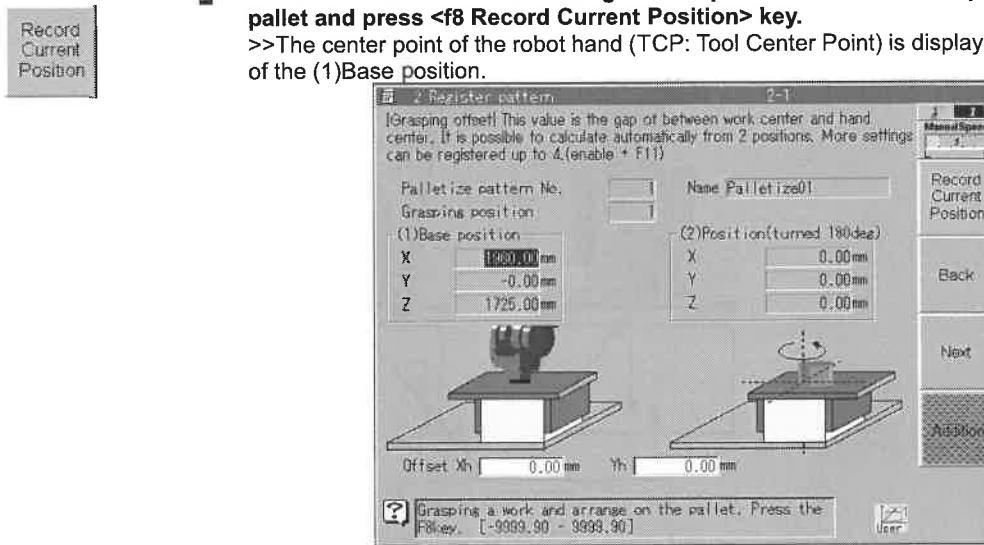
- 1 Set the cursor to "X" of the "(1)Base position".**



(Note) When software version AXV08.10 or before is used, please look at the last page of this section for referring this picture.

- 2 Move the robot which is holding a work-piece to the reference position on a pallet and press <f8 Record Current Position> key.**

>>The center point of the robot hand (TCP: Tool Center Point) is displayed on (X,Y,Z) of the (1)Base position.

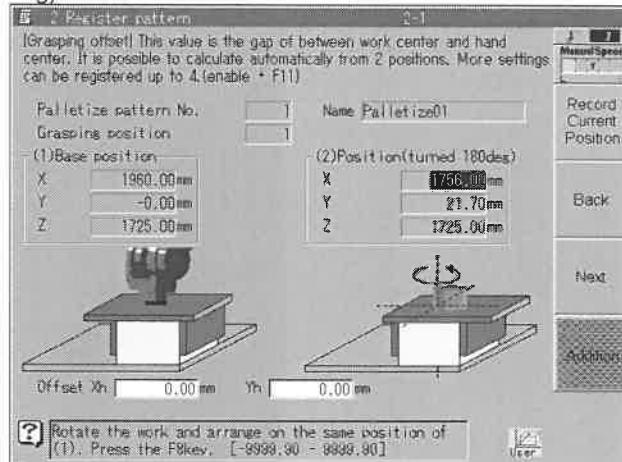


(Note) When software version AXV08.10 or before is used, please look at the last page of this section for referring this picture.

- 3 Set the cursor to "X" of the "(2)Position (turned 180deg)".**

Record
Current
Position

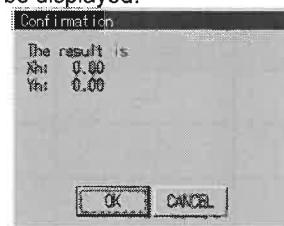
- 4** Rotate the work-piece around the reference position (180 degrees) and then place the work-piece on the same reference position. Then press <f8 Record Current Position> key.
 >>The current TCP position of the robot will be displayed on (X,Y,Z) of the (2)Position (turned 180 deg).



(Note) When software version AXV08.10 or before is used, please look at the last page of this section for referring this picture.

ENABLE +
or
Next

- 5** To add a grasping position, press [Enable] + <f11 Addition> key.
 To finish the registration of the grasping position, press <f10 Next> key.
 >>The calculated result will be displayed.



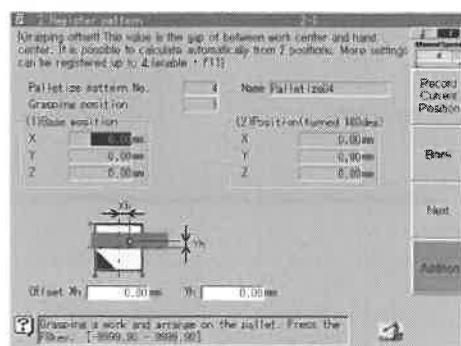
- 6** If the result is good, select [OK] and then press [Enter] key.
 >>If [Enable] + <f11 Addition> key is pressed, a screen of "Grasping offset" will be displayed again.
 >>If <f10 Next> key is pressed, [Layer setting] screen will be displayed.
 Concerning [Layer setting], refer to the Section 4.5.
- 7** When selecting [CANCEL] at 6, please restart the setting from the recording of the reference position.

POINT

To stop the automatic calculation in halfway, input the offset values directly. The recorded positions will be reset.

(Note)

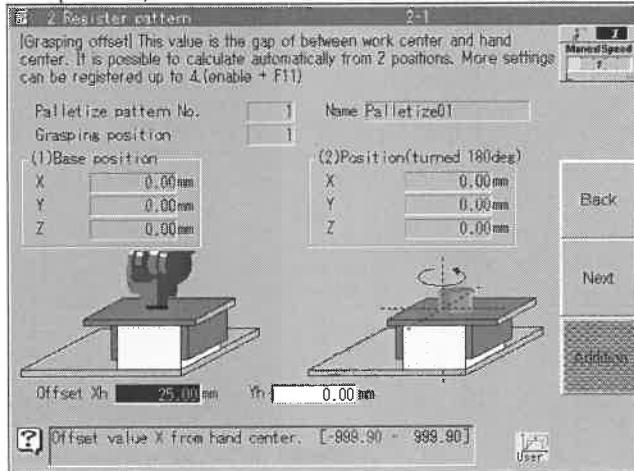
When software version AXV08.10 or before is used, displayed screen is as right figure. (guide picture is different with AXV08.011 and after)



4.4.2 Setting the grasping position manually



- 1 Set the cursor to "Offset Xh" or "Yh" and then input values. Then press [Enter].**
 >>If both "(1) Base position" and "(2)Position (turned 180deg)" are set already via position record operation, those values will be cleared to 0.0.



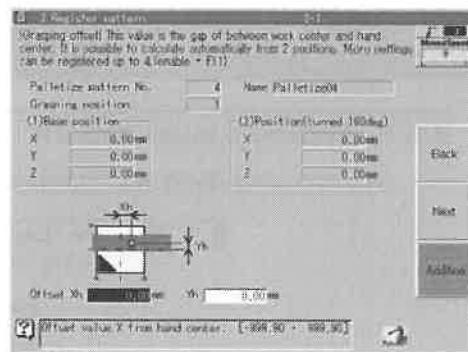
(Note) When software version AXV08.10 or before is used, please look at the last page of this section for referring this picture.

Table 4.4.1 Setting parameters in [Grasping offset] screen

Item	Initial value	Range	Description
Palletize pattern No.	---	----	The palletize pattern that is being edited now. This value cannot be changed.
Name	---	----	The name of the pattern. This value cannot be changed.
Grasping position	1	1 - 4	Registration number of the Grasping position. This value will increase up to 4 by adding grasping positions.
(1) Base position X, Y, Z	0.0	----	A reference data to calculate the Grasping position automatically. The values of this item will change when pressing <f8 Record Current Position> key. It is not possible to modify this setting manually one by one.
(2)Position (turned 180deg) X, Y, Z	0.0	----	A position data of 180 [deg] rotation to calculate the Grasping position automatically. The values of this item will change when pressing <f8 Record Current Position> key. It is not possible to modify this setting manually one by one.
Offset Xh	0.0	-999.9 - 999.9	An offset distance along X direction between the rotational center position (TCP) of the gripper that is grasping a work-piece and the center point of the work-piece that is being grasped. This value can be changed by automatic calculation or manual input.
Offset Yh	0.0	-999.9 - 999.9	An offset distance along Y direction between the rotational center position (TCP) of the gripper that is grasping a work-piece and the center point of the work-piece that is being grasped. This value can be changed by automatic calculation or manual input.

(Note)

When software version AXV08.10 or before is used, displayed screen is as right figure. (guide picture is different with AXV08.011 and after)



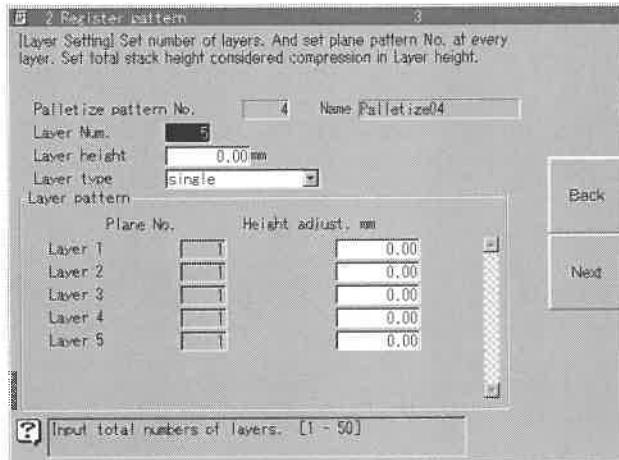
4.5 Registration of a layer pattern

4.5.1 Setting a layer pattern

A number of the layers or a "Plane No." that is used for respective layer (plane) can be set here.

1 Input the "Layer Num".

>>Following the inputted value, the number of the displayed "Layer pattern" will change.

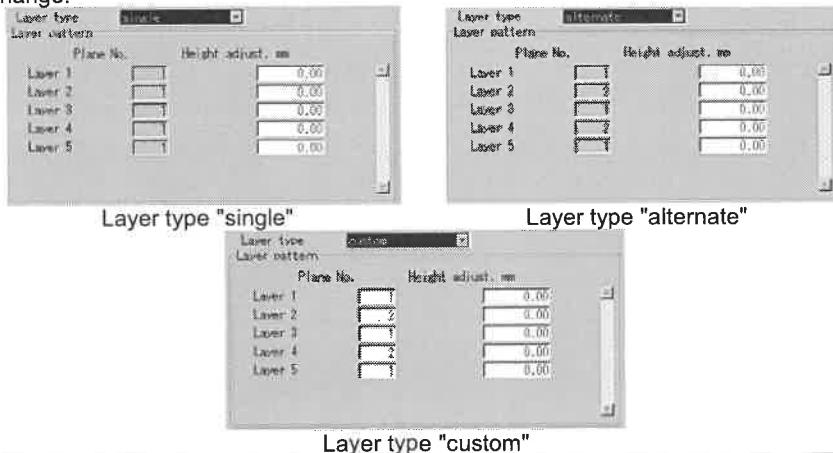


2 Input the "Layer height".

Concerning the adjustment of the height, refer to the Section 4.7 .

3 Select the "Layer type".

>>Following the selected layer type, the displayed contents for "Layer pattern" will change.



4 Input the "Plane No."

But, this setting cannot be changed if the layer type is "single" or "alternate".

In case of "custom", repeat setting of the Layer pattern is available. For details, refer to the Section "4.5.2 Repeating the layer pattern".

5 After completion of all data, press <f10 Next> key.

>>The next screen "Plane pattern setting" will be displayed.

For details, refer to the Section 4.6.

Next

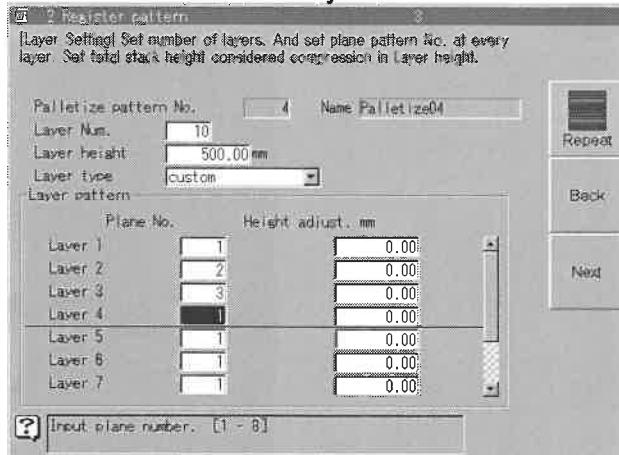
Table 4.5.1 Setting parameters in [Layer setting] screen

Item	Initial value	Range	Description
Palletize pattern No.	---	----	The palletize pattern that is being edited now. This value cannot be changed.
Name	---	----	The name of the pattern. This value cannot be changed.
Layer Num.	1	1 - 50	Total number of the layers to be palletized.
Layer height	0.0	0.0 - 9999.9	Total height of the loads when the palletize is finished.
Layer type	single	single / alternate / custom	Select a layer type from the following types.
			single Only 1 Plane No. is used for all the layers. The Plane No. for each layer is forcibly set to "1" and it becomes impossible to change the number.
			alternate 2 Plane No. are used alternately. The Plane No. of each layer is forcibly set to "1" or "2" and it becomes impossible to change the number.
			custom The layer pattern can be edit freely.
Layer pattern Plane No.	1	1 - 8	This is a plane pattern No. to be used for the layer. This setting is available only for "Custom".
Height adjust. mm	0.0	-9999.9 - 9999.9	Adjustment parameters for the respective layers. For details, refer to the Section 4.7

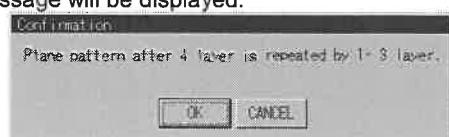
4.5.2 Repeating the layer pattern

When using "custom" for the "Layer type", it is possible to repeat the Layer pattern of from Layer 1 to Layer n for the following Layers (from n+1).

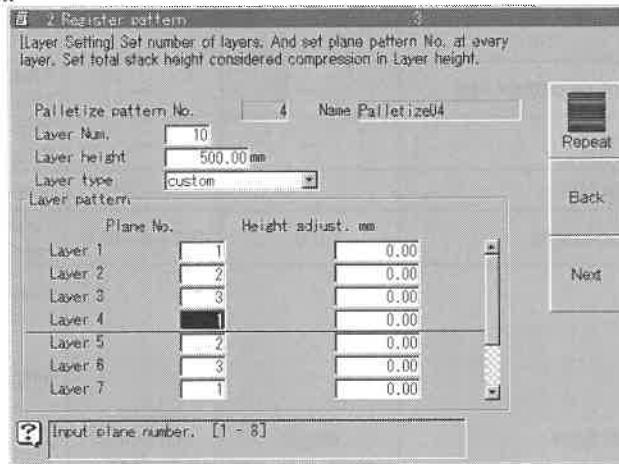
- 1 After selecting "Custom" for the Layer type, set the Plane No. for each layer from 1 to n. Then set the cursor to the layer "n+1".



- 2 Press <F8 Repeat> key.
>>The following message will be displayed.



- 3 If [OK] is selected, the following layers (from n+1) will change to make the repeat form.**



4.5.3 Superimposed display of Plane pattern

This item is available for the software of AXV08.011 and after.

Work-piece arrangement under editing can be checked by graphics display. Work-piece arrangement of plural layers can be checked, because they are displayed with superimposed graphics.

POINT

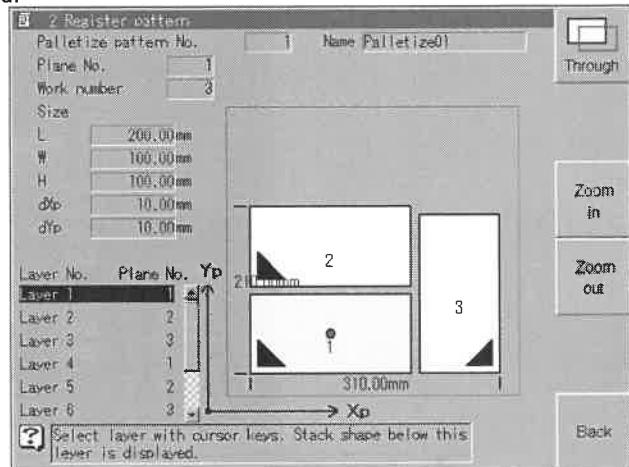
Explanations here is based on that work-piece arrangement is completed by plane pattern setting. At the first time to set palletize pattern, this display has no meaning because plane pattern is not fixed in this moment. Please set the plane pattern.

Please refer to 4.6 Plane pattern setting for the detail.

Check
Display

- 1 Press <f7 Check display> at plane pattern setting screen.**

» The plane pattern of bottom layer to be edited right now is displayed by graphics as followed.

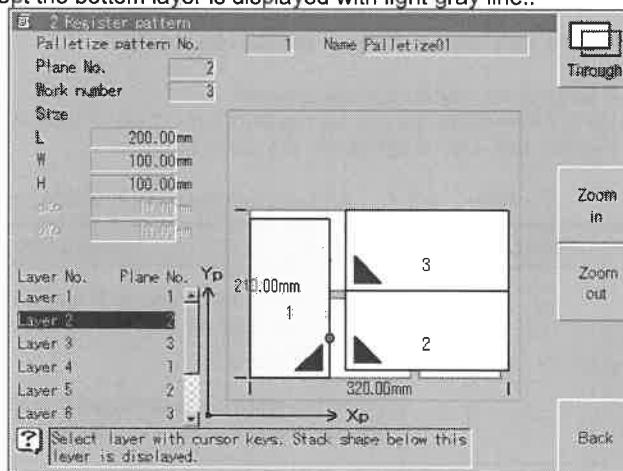


Also, work-piece size calculated by the work-piece arrangement is displayed here.



2 Select layer by up/down key.

» All of layers under the selected layer is displayed with superimposed graphics
Layers except the bottom layer is displayed with light gray line..

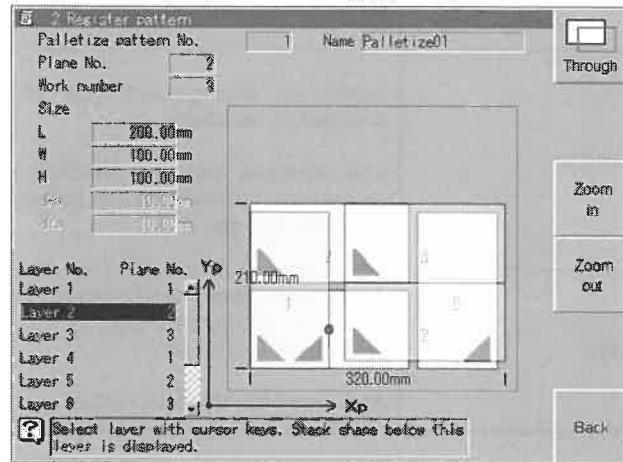


Work-piece size is calculated by the work arrangement all displayed layers.

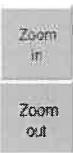


3 Press <f7 Through>.

» Top layer becomes semi-transparent display in order to check the superimposing shape.



Press f7 <Through> again or press up/down key to return back to the original display.



4 Press <f9 Zoom in>.

» Zoom in graphics is displayed.

5 Press <f10 Zoom out>.

» Zoom out graphics is displayed.

6 Press <f12 Back>.

» Graphics display is cleared and back to the layer pattern setting screen.



Displayed item indicates the layer information selected by up/down key.

Refer to 4.6.4 Check display for plane pattern for detail of them.

4.6 Plane pattern setting

How the work-pieces are arranged can be set here.

- 4 arrangement types can be selected.
- Up to 99 work-pieces can be registered per 1 plane pattern.
- Parallel shift can be applied to the plane pattern.

Table 4.6.1 Arrangement patterns that are available for plane pattern

Item	Description	Example
Column	<p>Arrange the work-pieces in X and Y direction in turn. Set the number of the work-pieces for X and Y direction respectively.</p> <p>The work-pieces are arranged in a shape of grid by following the parameters of Size L, Size W, gap dXp, and gap dYp.</p>	
Inter lock	<p>Select an arrangement type of work-pieces from the pre-defined templates.</p> <p>The positions and the directions of the work-pieces are determined by following the parameters of Size L, Size W, gap dXp, and gap dYp.</p>	
Pin wheel	<p>Select an arrangement type of work-pieces from the pre-defined templates.</p> <p>The positions and the directions of the work-pieces are determined by following the parameters of Size L, Size W, gap dXp, and gap dYp.</p>	
Custom	<p>All the work-pieces can be placed freely. The X, Y, Z positions and the Z-axis rotation angle of the work-piece can be set.</p> <p>And, approach direction can be set also.</p>	



It is possible to check the setting visually by using <f7 Check Display> key.
For Check Display function, refer to the Section "4.6.4 Check display for plane pattern"



If it is necessary to modify the arrangement pattern of "Column", "Inter lock", and "Pin wheel" respectively, press <f11 Modify> key. The setting data is developed (converted) to a format of "Custom".

However, once the development operation has been performed, it becomes impossible to return the data to the format of original arrangement types. (If an arrangement type is re-selected, the data will be initialized)

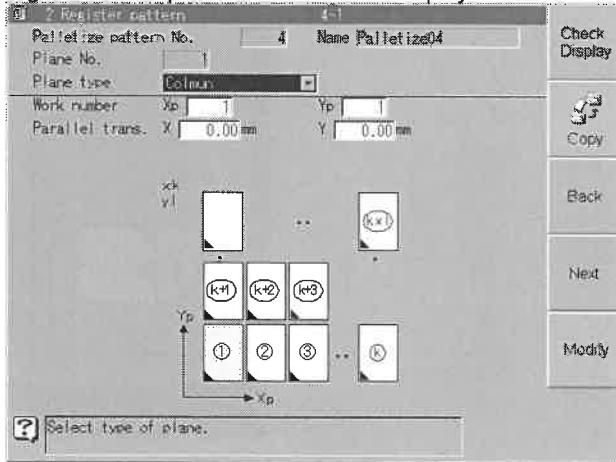
4.6.1 Setting of "column"

The number of work-pieces along the X-direction and the Y-direction of the pallet can be set in the following screen.

The arrangement order is set like the following figures.

1 Select "column" in the "Plane type".

>>A layout diagram of work-pieces for "column" is displayed on the screen.



2 Input the "Work number".

3 Input the "Parallel trans(X and Y)".

For details, refer to "4.6.5 Parallel translation of plane pattern"

4 To check the layout visually, press <f8 Check Display> key.

>>The layout will be displayed graphically on the screen.

For details, refer to "4.6.4 Check display for plane pattern".

Check
Display

Modify

5 To modify the settings, press <f11 Modify> key.

>>"Plane type" will be changed to "Custom" and the settings will be developed to the custom display. For the setting procedure of "Custom", refer to "4.6.3 Setting of "Custom""

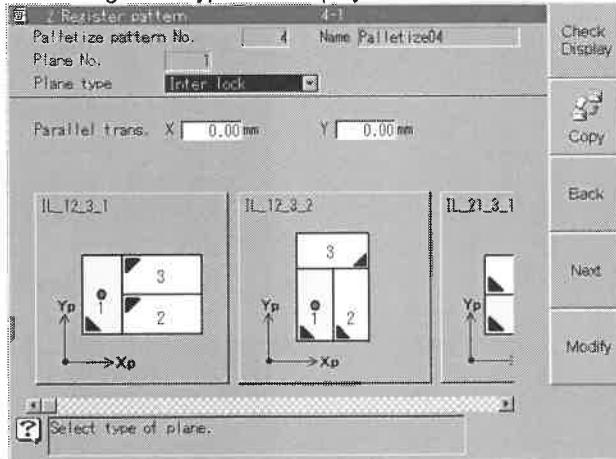


Once this operation (Modify) has been done, the "Plane type" can not return to "Column" keeping the setting values. If "Plane type" is changed, the settings in this screen will be reset.

4.6.2 Setting of "Inter lock" / "Pin wheel"

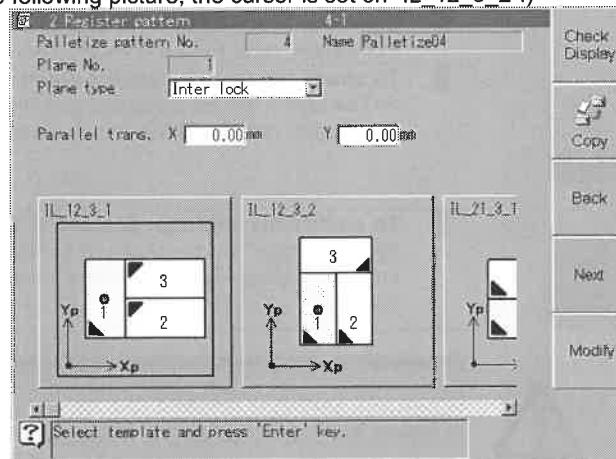
The setting procedure for "Inter lock" and "Pin wheel" is the same.
The setting procedure for "Inter lock" is described here.

- 1 Change the "Plane type" to "Inter lock" (or "Pin wheel").
>>The available arrangement types are displayed.



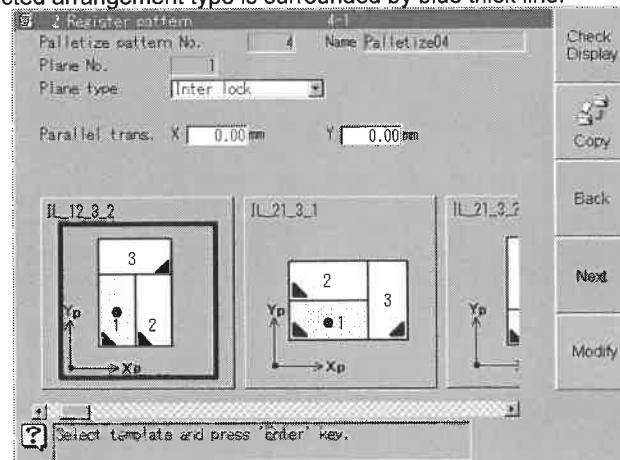
- 2 Set the cursor to the desired arrangement type.

>>On the position where the cursor is set, blue thin line will surround the arrangement type. (In the following picture, the cursor is set on "IL_12_3_2".)



- 3 Select the desired arrangement type using the cursor keys and press [Enter].

>>The selected arrangement type is surrounded by blue thick line.



4 Input the "Parallel trans(X and Y)".

For details, refer to "4.6.5 Parallel translation of plane pattern"

Check
Display

5 To check the layout visually, press <f8 Check Display> key.

>>The layout will be displayed graphically on the screen.

For details, refer to "4.6.4 Check display for plane pattern".

Modify

6 To modify the settings, press <f11 Modify> key.

>>"Plane type" will be changed to "Custom" and the settings will be developed to the custom display. For the setting procedure of "Custom", refer to "4.6.3 Setting of "Custom""



CAUTION

The actual directions and the positions of the work-pieces depend on the size setting for the work-piece and the arrangement types. Because the pictures shown on the previous pages are just template (sample) graphics, the actual arrangement of the work-pieces may look differ from those template graphics. Therefore, please do not forget to check the arrangement of the work-pieces using <f8 Check Display> key all the time.



CAUTION

Once this operation (Modify) has been done, the "Plane type" can not return to "Inter lock" (or "Pin wheel") keeping the setting values. If "Plane type" is changed, the settings in this screen will be reset.

4.6.3 Setting of "Custom"

If "Plane type" is set to "Custom", it becomes possible to set the arrangement of the work-pieces freely. If <f11 Modify> key is pressed with "Column", "Inter lock", or "Pin wheel" is selected, the setting data will be converted for "Custom" and displayed on the screen.

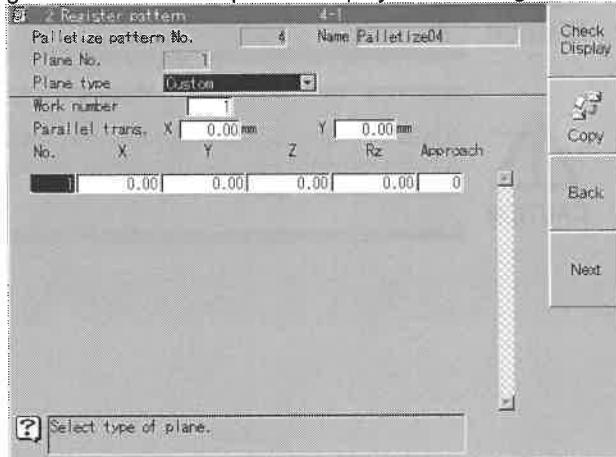


If "Plane type" is set to "Custom", the parameters of "Work size L", "Work size W", "dXp", and "dYp" are not used. But "Work size L" and "Work size W" are used for "Check Display".

CAUTION

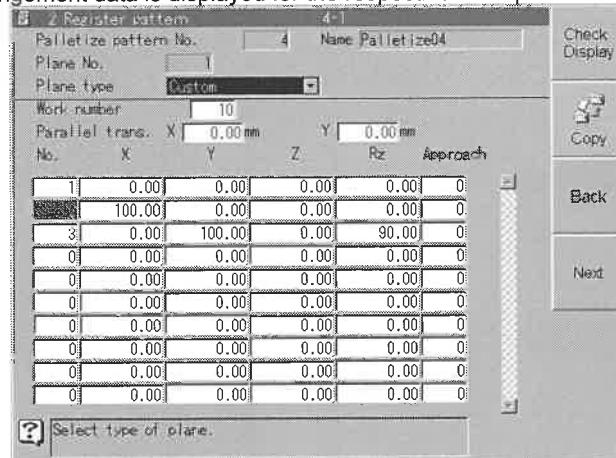
1 Change the "Plane type" to "Custom".

>>The arrangement data for work-piece is displayed like the figure shown below.



2 Input the "Work number".

>>The arrangement data is displayed for the respective work-pieces.



(NOTE)

When entering this screen by pressing <f11 Modify> key from "Column", "Inter lock", or "Pin wheel", the setting data will be developed(converted) for "Custom" and automatically set and displayed.

3 Input the respective work-piece numbers and the positions (X,Y,Z,Rz).

In case of (0,0,0,0), the teaching point is played back as it is. (=no shift motion)
Concerning the height (Z), refer to the Section "4.7 Adjusting the height".

4 Input the Approach direction.

Concerning the Approach direction, refer to the Section "5.2.3 FN374 Palletize approach selection".

5 Input the "Parallel trans(X and Y)".

For details, refer to "4.6.5 Parallel translation of plane pattern"

6 To check the setting visually, press <f8 Check Display> key.

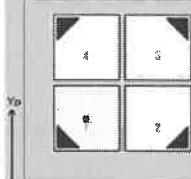
>>The layout will be displayed graphically on the screen.

For details, refer to "4.6.4 Check display for plane pattern".

Table 4.6.2 Setting parameters in [Plane type "Custom"] screen

Item	Initial value	Range	Description
No.	0	1 - 99	The order to arrange the work-piece.
X	0.0	-9999.9 - 9999.9	Work-piece center position along X-direction of the pallet coordinate system. Set the distance from the teach point.
Y	0.0	-9999.9 - 9999.9	Work-piece center position along Y-direction of the pallet coordinate system. Set the distance from the teach point.
Z	0.0	-9999.9 - 9999.9	Work-piece center position along Z-direction of the pallet coordinate system. This height can be tweaked for each work-pieces respectively. Concerning the height, refer to the Section "4.7 Adjusting the height".
Rz	0.0	-360 to 360	Rotation angle around the Z axis. The angle in the teach point itself is "0 [deg]".
Approach (direction)	0	0 - 8	A value to set the Approach direction. In case of "0", approach motion is not be made. For details, refer to the Section 5.2.3.

Example

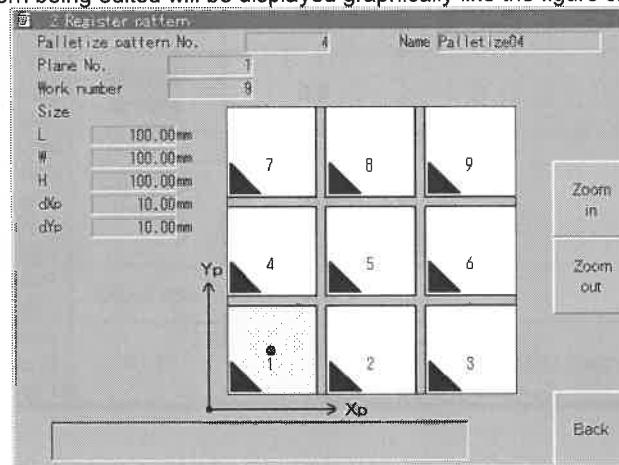
Arrangement	Work-piece	No.	X	Y	Z	Rz	Approach direction
 L : 100 W : 100 H : 100		1	0.0	0	0.0	0	0
		2	110.0	0.00	0.0	90	0
		3	110.0	110.0	0.0	180	0
		4	0.0	110.0	0.0	-90	0

4.6.4 Check display for plane pattern

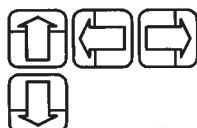
The plane pattern being edited can be checked graphically.



- 1 Press <f7 Check Display> key in the plane pattern setting screen.
 >>The pattern being edited will be displayed graphically like the figure shown below.



Also, work-piece size calculated by the work-piece arrangement is displayed here.



- 2 Press up/down/left/right cursor keys.
 >>The graphic will move to the respective directions.



- 3 Press <f9 Zoom in> key.
 >>The graphic will be zoomed in.



- 4 Press <f9 Zoom out> key.
 >>The graphic will be zoomed out.

- 5 Press <f12 Back> key.
 >>The graphical display will be closed and the screen will return to the plane pattern setting screen.

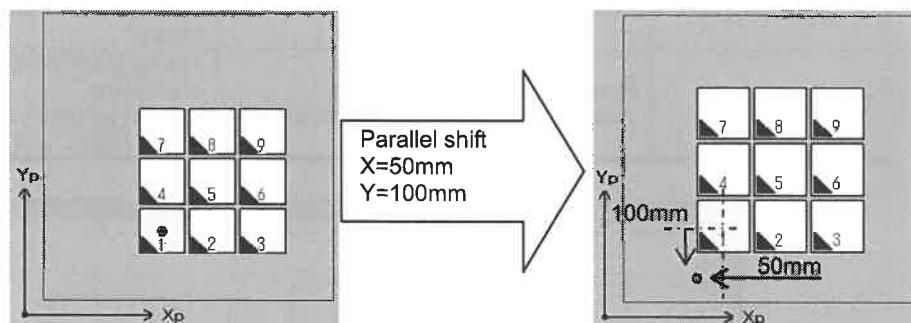
Table 4.6.3 Items displayed on [Check Display] screen

Item	Description
Palletize pattern No.	The number of the palletize pattern currently being edited.
Name	Name of the palletize pattern.
Plane No.	The number of the plane pattern currently being edited.
Work number	The number of the work-pieces being edited in the current plane pattern edit screen.
Size L	The size of the work-piece(L)
W	The size of the work-piece(W)
H	The size of the work-piece(H)
dXp	The gap between the work-pieces in X-direction (dXp).
dYp	The gap between the work-pieces in Y-direction (dYp).
	The 1st work-piece is displayed in yellow. The other work-pieces are displayed in white. The number in the work-piece shows the order in which the work-piece is stacked. The filled triangle on the lower left-hand is used to show the rotation angle.

Item	Description
	This mark shows the teach point of the palletize program. Normally, the teach point is placed at the center point of the 1st work-piece. But when setting parallel translation, the position will follow the setting. Refer to the Section "4.6.5 Parallel translation of plane pattern".
	■ Available for the software of AXV08.011 and after Maximum size of each X and Y direction is displayed when work-pieces are arranged on this plane.

4.6.5 Parallel translation of plane pattern

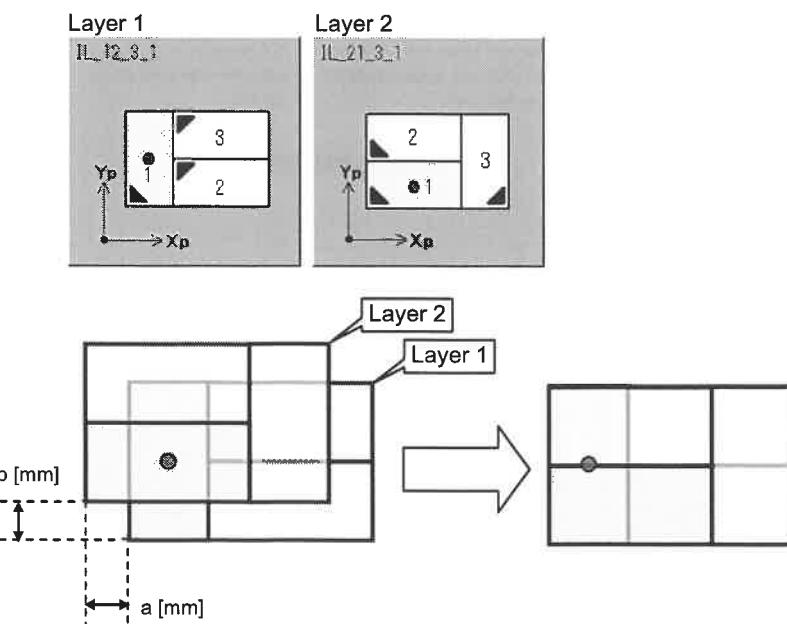
The all work-pieces included in a plane pattern can be shifted parallel together to adjust their positions against the upper/lower layers. By executing parallel shift, the all work-pieces in the plane pattern will move parallel from the shift reference point (teach point) like the figure shown below.



If parallel shift is set, the teach point is not the center point of the 1st work-piece on the plane pattern.

CAUTION

An example in which the parallel shift setting is necessary



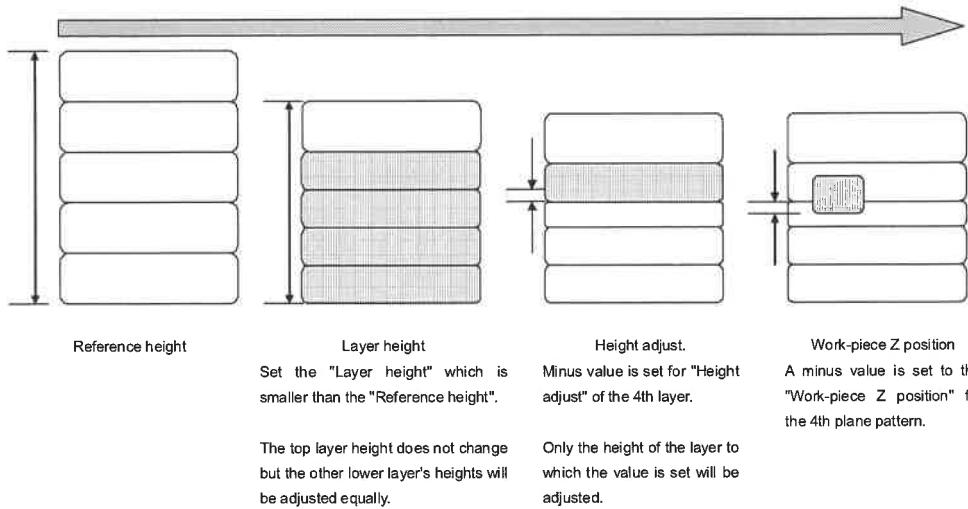
In a case like this, apply parallel shift for Layer 2.
 $X = +a$ [mm], $Y = -b$ [mm]

4.7 Adjusting the height

The height of the wok-pieces of each plane (layer) is determined using the following parameters.

Table 4.7.1 Setting items for height

Item	Setting screen	Target	Description
Reference height		All layers	Reference value for the total height of the stacked work-pieces. The calculation will be done like following: "Work size H" x "Layer Num."
Work size H	[Work information]		
Layer Num.	[Layer setting]		
Layer height	[Layer setting]	All layers	If this value is smaller than the "Reference height", each layer's height except for the top layer will be adjusted.
Height adjust.	[Layer setting]	Each Layer	The height of each layer can be adjusted one by one. This adjustment value will be added to the adjustment value calculated from "Layer height"
Work Z	Plane pattern setting screen	Per Work-piece	The height of each work-piece can be adjusted one by one. This adjustment value will be added to that of "Layer height" and "Height adjust".



Height adjustment

Chapter 5 Teaching

This chapter describes the teaching procedures for palletizing. Palletizing is accomplished by combining a number of application commands (functions).

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5.1 General description of teaching

The palletizing is recorded in work programs using application commands (functions). Palletizing start, end, etc. are specified, using parameters such as the palletizing numbers.

The application commands which are used are listed in the table below. Details on each command can be found on the following pages.

And, it is also possible to use application commands (functions) that can modify palletize registers to make an high-level motion. For details, refer to the Section 6.3.

Table 5.1-1 Application commands used by palletizing

FN code No.	Name of FN command	Outline
249	Palletize start	Start palletizing based on the pre-designed palletizing pattern.
250	Palletize end	Finish palletizing based on the pre-designed palletizing pattern.
251	Palletize reset	The palletize counters (Layer and Work-piece) are forcibly reset. (palletizing operation is forcibly terminated)
374	Palletize approach selection	Starts approaching motion.
375	Palletize optimize path	Optimize Step position based on the locus of previous step and following step.
376	Palletize select grasp position	Select work grasp position from registered by Palletize pattern.

5.2 Application commands (functions)

5.2.1 FN249 Palletize start, FN250 Palletize end

FN249 is the palletize start command.

Palletizing is started with this application command. "Palletizing operations" involve calculating the shift amount based on the specified palletizing number and palletize counter and playing back the positions which have been offset from the original positions by the shift amount. These shift operations continue until the next "FN250 Palletize end" application command is executed.

The 3rd parameter and the 4th parameter are used to designate the output signal number for "Layer counter" and "Work-piece counter". Those output signals are refreshed at the timing of executing "Palletize start" / "Palletize end" application commands.

Mnemonic	Number	Command
PALLET3	FN249	Palletize start
Parameter	Data	Description, setting range
1st parameter	Palletize No.	The number of the palletize to start (1-100)
2nd parameter	Type	Designate "Palletize" or "De-palletize". (0:Palletize / 1:De-palletize)
3rd parameter	Layer count signal number	This is a first number of the signals to output the Layer counter value. (0-2048) The counter value is outputted in binary form and this signal number is handled as the LSB. Continuous 6 signals (6 bits) from this signal number are used at maximum (from 1st to 50th layer) If "0" is designated, the signals are not outputted.
4th parameter	Work-piece count signal number	This is a first number of the signals to output the Work-piece counter value. (0-2048) The counter value is outputted in binary form and this signal number is handled as the LSB. Continuous 7 signals (7 bits) from this signal number are used at maximum (from 1st to 99th work-piece) If "0" is designated, the signals are not outputted.

FN250 is the palletize end command. This is paired with the "FN249 Palletize start" command.

It ends the palletizing pattern being executed, and increments the Work-piece counter by 1. If, as a result of the incrementation, the Work-piece counter has exceeded the total number of Work-pieces for the layer, the Layer counter is incremented and the Work-piece counter is returned to 1. If the Layer counter has exceeded the total number of Layers for the palletize pattern, the Layer counter is returned to 1 and the completion signal will be turned ON.

In case of de-palletize, the counter will be decremented by 1 from the maximum number of Work-pieces.

Mnemonic	Number	Command
PALLET3 END	FN250	Palletize end
Parameter	Data	Description, setting range
1st parameter	Palletize No.	The number of the palletize to finish (1-100)

2nd parameter	Completion signal	When the designated palletize is completely finished, the designated output signal will turn ON. (from 0 to 2048) If "0" is designated, the signals are not outputted.
---------------	-------------------	--

Record "PALLET3 : Palletize start(FN249)" at STEP N and "PALLET3_END : Palletize end(FN250)" at STEP N+3

When playing back the work program, after reaching the STEP N,
the robot will start shift motion by calculating the shift amount based on the palletize number
designated in FN249 and the palletize counter (Layer counter and the Work-piece counter). For
example, the robot will go thorough the dotted line in the picture shown below. After reaching
STEP N+3, FN250 is executed and the palletize motion will be finished and then the robot will go
towards the record point (teach point) of the STEP N+4.

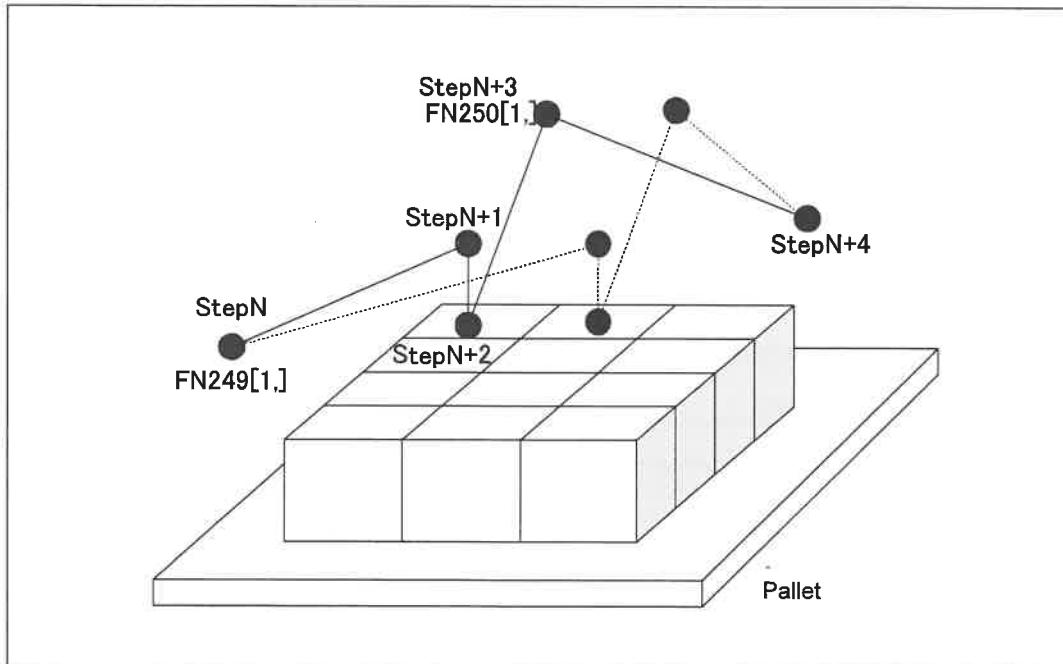


Fig. 5.2.1-1 Example of operations from "FN249 Palletize start" and "FN250 Palletize end"

5.2.2 FN251 Palletize reset

Using this application command, the palletize counter (both "Layer counter" and "Work-piece counter") can be forcibly reset. (Cleared to zero)

The palletize that has been reset will re-start from the 1st work-piece of the 1st layer.

The reset operation is available even if the palletize operation is being executed or has been already finished. If the reset is done while the palletize operation is being executed, the palletize condition is forcibly set to "Finished".

When resetting the palletize, if the palletize has been started, the output signals for "Layer counter" and the "Work-piece counter" will be cleared.

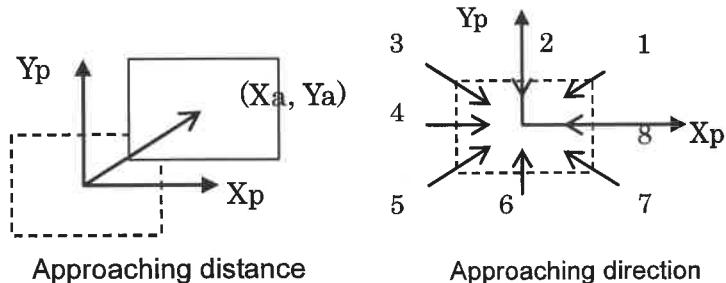
When resetting, an output signal "Reset ACK signal" will be turned ON.

Mnemonic	Number	Command
PALLET3_RESET	FN251	Palletize reset
Parameter	Data	Description, setting range
1st parameter	Palletize No.	The number of the palletize to reset the counters (Layer and the Work-piece) (1-100)

5.2.3 FN374 Palletize approach selection

"Approach" is the robot moving to be closing to the pallet with slant direction in order to avoid the interference with the already loaded work-piece and to make small clearance between the already loaded work-piece. Normally approaching direction has to be changed according to the palletizing direction, so simple shift is not enough to realize this movement.

One approach distance is defined by palletize pattern, and approach direction is designated for each work-piece. By this command, approach movement can be changed from the next step.



Mnemonic	Number	Command
PALLET3 APR	FN374	Palletize approach selection
Parameter	Data	Description, setting range
1st Parameter	Palletize No.	The target palletize number (1-100)
2nd parameter	Route selection	0:appr-down 1:down-appr

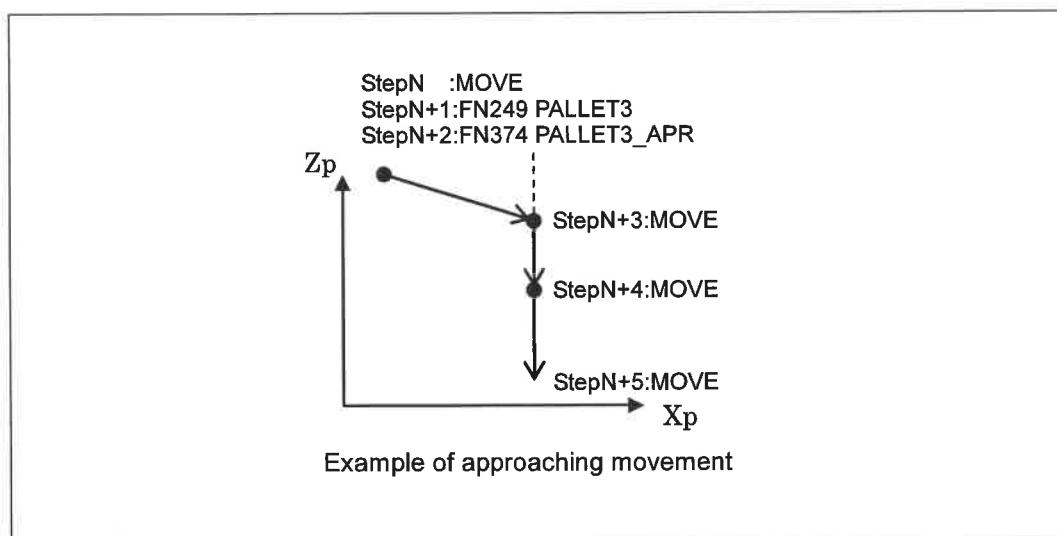
Approaching movement

Approach shift is added on the next move step of PALLET3_APRL step (In case that down-appr is designated, this includes next of next move step). Pay much attention when adding move step.

As written in the following figure, FN249 (PALLET3) is recorded in step N+1. FN374 (PALLT3_APRL) is recorded in step N+2, and move step N+2, N+3 and N+4 continues.

Robot will start palletizing shift movement according to the palletize pattern designated by FN249 and the palletize counter in this moment.

At the next move step of FN374 (PALLET3_APRL), approach shift amount designated to this work-piece is added on the palletize shift amount.



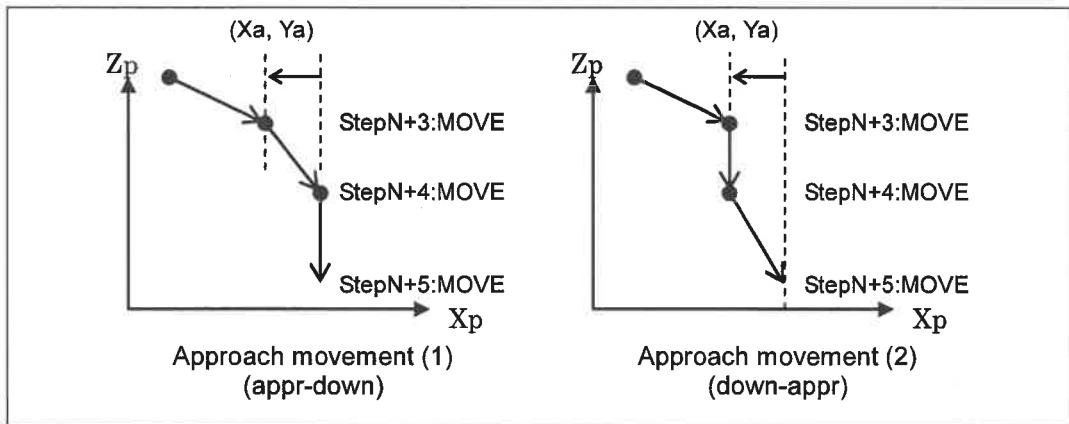


Fig 5.2.3-1 Example of approaching movement

5.2.4 FN375 Palletize optimize path

If the total height of the stacked work-pieces is large, if the teaching program is made to avoid the stacked work-pieces or the other hurdles, redundant motion may occur in the program.

This is an application command to adjust the move step position automatically by referring the motion locus before/after the step.

Mnemonic	Number	Command
PALLET3_OPT	FN375	Palletize optimize path
Parameter	Data	Description, setting range
1st Parameter	Palletize No.	The target palletize number (1-100)
2nd parameter	Reference step No.	The number of a move step which is referred to. (from 1 to 9999)

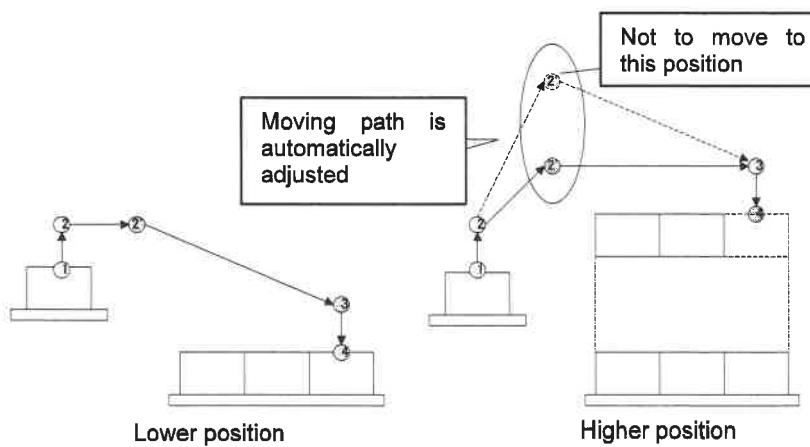
Specifically, the target position of 2 following move steps are compared and the one of which the Z coordinate is higher

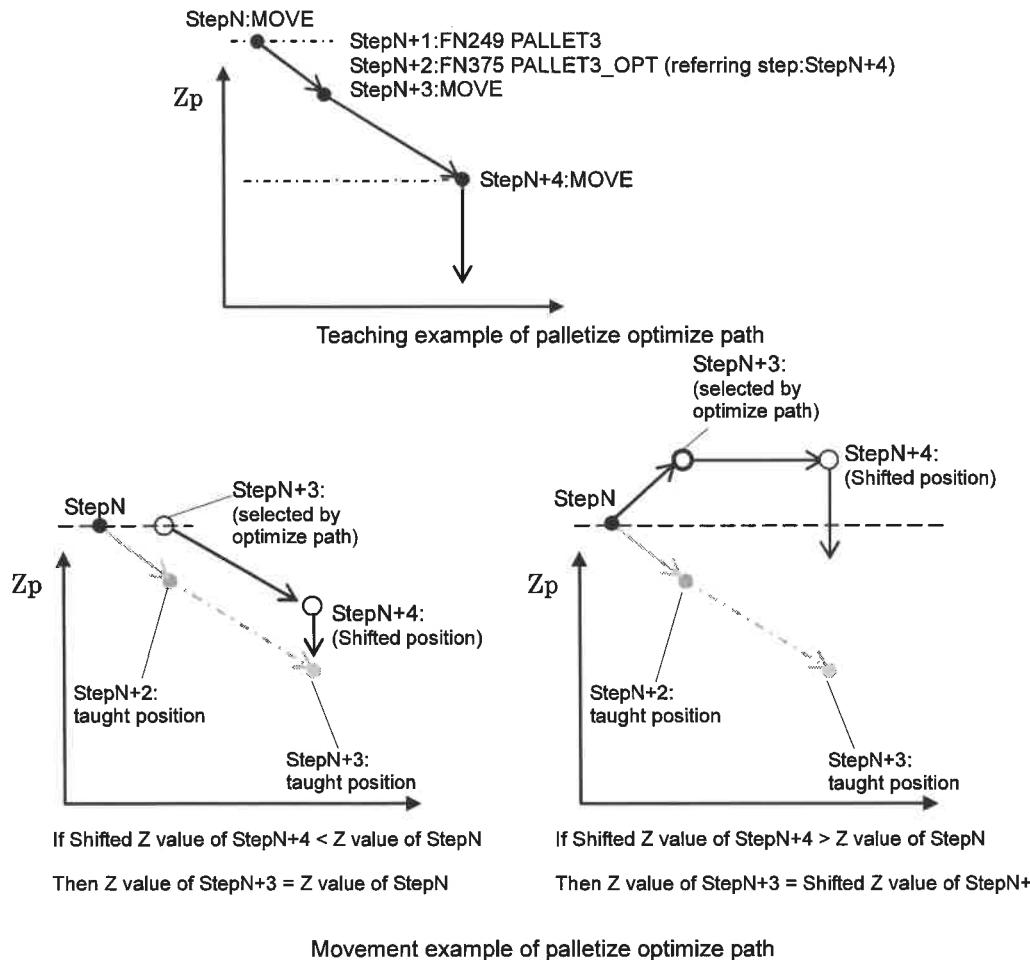
Z coordinate following move command is modified so that the value becomes the same with the higher one.

Concretely, Z coordinate value of "next move step" is aligned to the higher Z value of two move step target position.

Two move steps are "previous move step" of this function and "referred move step" designated by parameter.

Z coordinate value is calculated on the base of the pallet coordinate system that is currently used in this palletize pattern.





5.2.5 FN376 Palletize select grasp position

Select one of the "Grasping position"(up to 4 at maximum) registered in the palletize pattern.

For example, please suppose that several work-pieces are grasped by a hand (gripper) at one time and the robot will release (put) those work-pieces one by one on the pallet. Although the robot move to the position of the work-piece registered to the palletize pattern, the robot cannot put those work-pieces precisely because the grasping position will change every time per the work-piece.

Using this function, grasping position can be adjusted to the adequate position for each work-piece in order to put the target position of the robot on the center of work-piece..

If this function is not executed, robot moves just like that "Grasping position" is registered as 1.
If this function is executed once or more and "Grasping position" is changed, this will be kept until the palletize number is reset.

Mnemonic	Number	Command
PALLET3_SELGR	FN376	Palletize select grasp position
Parameter	Data	Description, setting range
1st Parameter	Palletize No.	The target palletize number (1-100)
2nd parameter	Grasp position	Grasping position number of the work-piece to be selected (1-4)

5.3 Creating a palletize program

5.3.1 Outline

It is possible to create a basic palletizing/de-palletizing program only by setting parameters following the setting in the screens. The setting procedure is a sequential work.

Please make a program following the procedures shown as below.

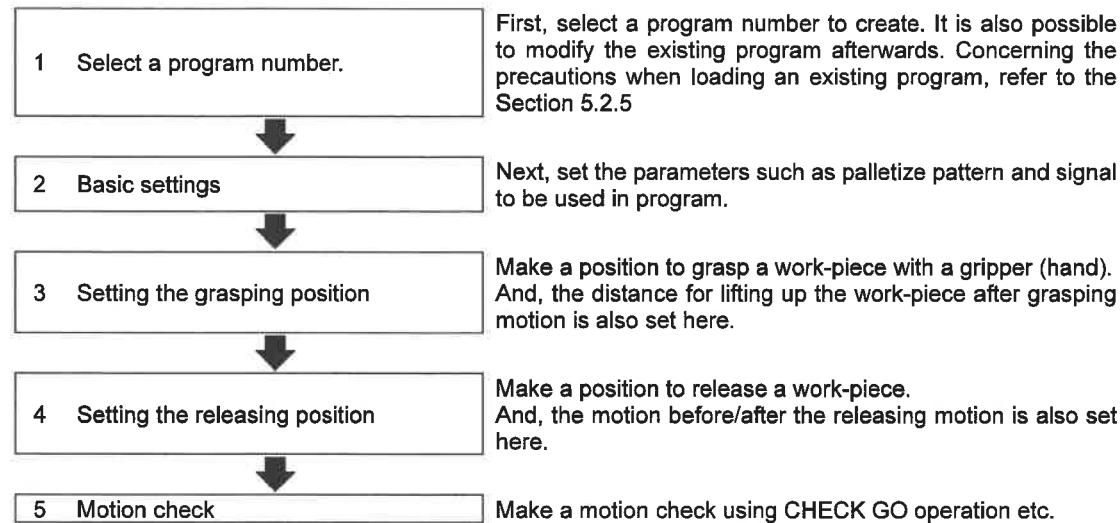


Fig. 5.3.1-1 Palletize program creating procedure

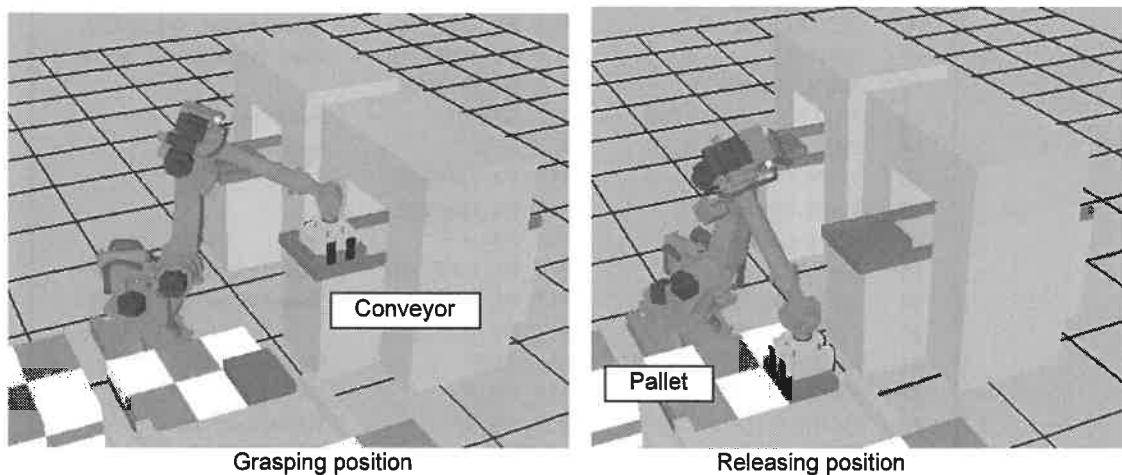


Fig 5.3.1-2 The grasping position and the releasing position for the palletize

Palletize program

The motion of the program to be created would be like the figure shown as below. The robot will pick the work-pieces up using (2) as a grip point and then start an approach motion from (4). And the work-piece is placed (released) at (6) on the pallet and the robot moves to (7). The palletize function is started at the position of (3) and finished at the position of (7).

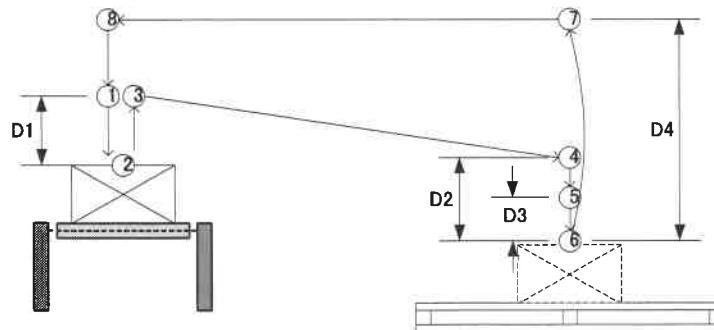


Fig. 5.3.1-3 The motion of the program to be generated (palletize)

1	REM[""]	PROGRAM_NAME	Program name
2	*TOP	PLT_P0_TOP	Loop tag
3	SETM [O2,0]	PLT_P0_OFF_HC	"Hand close" signal OFF
4	SETM [O1,1]	PLT_P0_ON_HO	"Hand open" signal ON
5	100% LIN A8 T2	PLT_P1_P	
6	WAITI[I3]	PLT_P1_WAIT_WK	Wait "Work wait" signal
7	WAITI[I1]	PLT_P1_WAIT_HO	Wait "Hand open" signal
8	30% LIN A1 T2	PLT_P2_P	
9	SETM[O1,0]	PLT_P2_OFF_HO	"Hand open" signal OFF
10	SETM[O2,1]	PLT_P2_ON_HC	"Hand close" signal ON
11	WAITI[I2]	PLT_P2_WAIT_HC	Wait "Hand close" signal
12	100% LIN A8 T1	PLT_P3_D1=100	
13	PALLET3[1,0,O3,O4]	PLT_START	Palletize
14	PALLET3_APP [1,1]	PLT_APRA	Approach
15	100% LIN A8 T1	PLT_P4_D2=200	
16	100% LIN A8 T1	PLT_P5_D3=100	
17	30% LIN A1 T1	PLT_P6_P	
18	SETM[O2,0]	PLT_P6_OFF_HC	"Hand close" signal OFF
19	SETM[O1,1]	PLT_P6_ON_HO	"Hand open" signal ON
20	100% LIN A8 T2	PLT_P7_D4=2000	
21	PALLET3_END [1,O5]	PLT_END	Palletize end
22	100% LIN A8 T2	PLT_P8_P	
23	GOTO *TOP	PLT_P8_JP	To the loop top
24	END	PROGRAM_END	Program end

POINT

Tool number recorded in move step is as followed.
T1 (tool 1) is while grasping work-piece with hand.
T2 (tool 2) is not while grasping work-piece with hand.

De-palletize program

The motion of the program to be created would be like the figure shown as below. The robot will pick the work-pieces up using (2) as a grip point and raise up to (3). Then robot releases the work-piece at the position of (6) on the pallet and takes shelter to the position of (5). No approach motion executed. The palletize function is started before going to the position of (1) and finished at the position of (3).

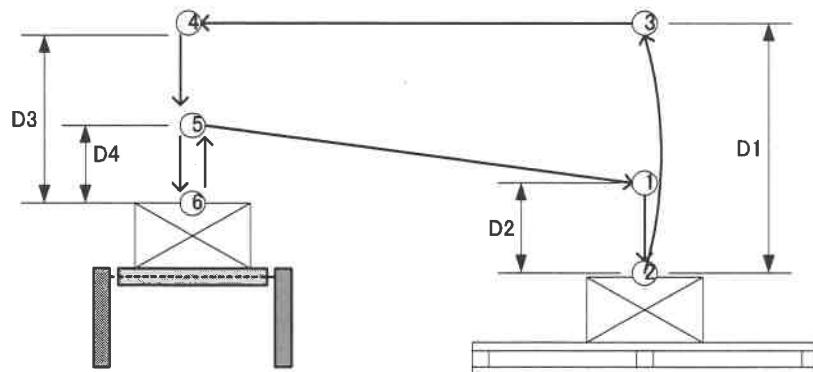


Fig 5.3.1-4 The motion of the program to be generated (de-palletize)

1	REM[""]	PROGRAM_NAME	Program name
2	*TOP	PLT_P0_TOP	Loop tag
3	PALLET3[5,1,O3,O4]	DPLT_START	
4	100% LIN A8 T2	DPLT_P1_D1=200	
5	SETM[O1,0]	DPLT_P1_OFF_HO	"Hand open" signal OFF
6	SETM[O2,0]	DPLT_P1_ON_HC	"Hand close" signal OFF
7	SETM[O1,1]	DPLT_P1_ON_HO	"Hand open" signal ON
8	10% LIN A1 T2	DPLT_P2_P	
9	SETM[O1,0]	DPLT_P2_OFF_HO	"Hand open" signal OFF
10	SETM[O2,1]	DPLT_P2_ON_HC	"Hand close" signal ON
11	WAITI[I2]	DPLT_P2_WAIT_HC	Wait "Hand close" signal
12	100% LIN A8 T1	DPLT_P3_D2=500	
13	PALLET3_END[5,O5]	DPLT_END	Palletize end
14	WAITI[I3]	DPLT_P3_WAIT_WK	Wait "waiting to put a work" signal
15	100% LIN A8 T1	DPLT_P4_D3=500	
16	100% LIN A8 T1	DPLT_P5_D4=200	
17	SETM[O2,0]	DPLT_P5_OFF_HC	"Hand close" signal OFF
18	10% LIN A1 T1	DPLT_P6_P	
19	SETM[O1,1]	DPLT_P6_SET_HO	"Hand open" signal ON
20	WAITI[I1]	DPLT_P6_WAIT_HO	Wait "Hand open" signal
21	100% LIN A8 T2	DPLT_P7_P	
22	GOTO[*TOP]	DPLT_P7_JP	
23	END	PROGRAM_END	

POINT

Tool number recorded in move step is as followed.
T1 (tool 1) is while grasping work-piece with hand.
T2 (tool 2) is not while grasping work-piece with hand.

A palletizing program and a de-palletizing program can be generated in the same procedure.
The procedure for palletizing program generation is described hereinafter.

5.3.2 Basic setting

Please make a setting for the palletize pattern number, several signals, etc. that will be used in the palletizing program.

- 1 Select [3 Program creation] from "Palletize Constant".**

>>A list of programs like shown below is displayed.



Program list display		
Program No.	No. of Steps	Comment
1ST166F01.001	5	PALLET01
1ST166F01.002	5	PALLET
1ST166F01.003	24	

[?] Input program number or select program from list.
And press Enter key to next step.



- 2 Input a program number in which the program is generated and press [Enter] key.**

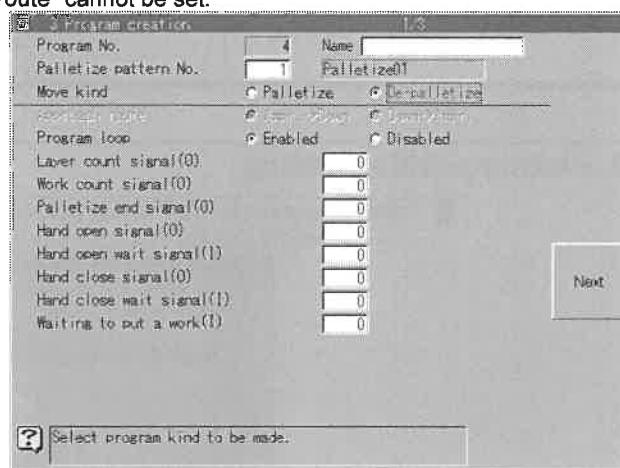
>>A basic setting screen like shown below is displayed.

Set the cursor to an existing program and press [Enter] to load the program.
Concerning the precautions for loading an existing program, refer to the Section 5.3.5
Modifying the created program.

Program No.	4	Name	Palletize01
Palletize pattern No.			
Move kind	<input type="radio"/> Palletize	<input type="radio"/> Depalletize	
Approach route	<input type="radio"/> Apr. ->Down	<input type="radio"/> Down->Apr.	
Program loop	<input type="radio"/> Enabled	<input type="radio"/> Disabled	
Laver count signal(0)	0		
Work count signal(0)	0		
Palletize end signal(0)	0		
Hand open signal(0)	0		
Hand open wait signal(1)	0		
Hand close signal(0)	0		
Hand close wait signal(1)	0		
Block wait signal(1)	0		

[?] Input pattern number.Press F8 key to show registered pattern list. [0 - 100]

When setting the "Move kind" to "De-palletize", or when loading an existing de-palletizing program, the screen will be like the figure shown below. (In this case, "Approach route" cannot be set.)



3 Set the respective parameters and then press <f10 Next> key.

For details of each parameter, refer to the following Table.

And, if an existing program has been loaded, the setting values of the program are displayed in the screen.

Next

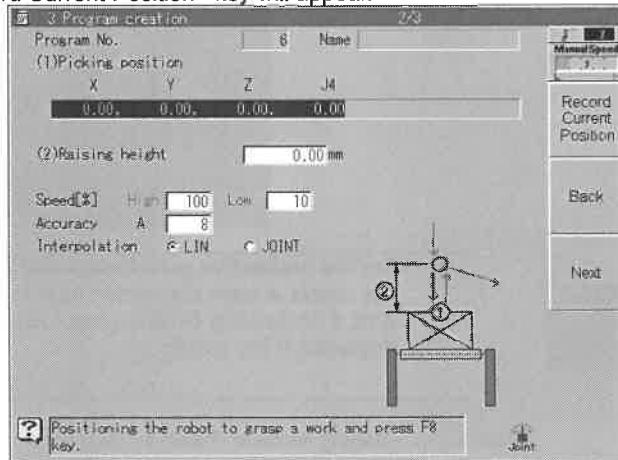
Table 5.3-1 Setting items in [Basic setting] screen (Palletize / De-Palletize)

Item	Initial setting	Range	Description
Program No.	---	---	The program number selected / inputted in the list screen is displayed here. This number cannot be modified in this screen.
Name	None		Name of the program.
Palletize pattern No. (Name)	1	1~100	A palletize pattern number which is used in the program to be generated is inputted here. When a cursor is here, it becomes possible to select a palletize pattern number from the palletize pattern list by pressing <f8 List> key.
Move kind	Palletize	Palletize/ de-palletize	Palletize or de-palletize to be used in the program can be selected here.
Approach route (Only for palletize)	Appr.->Down	Appr.->Down / Down->Appr.	This is an approaching route setting.
Program loop	Enabled	Enabled / Disabled	Select whether or not jumping to the top of the program from the end.
Layer count signal (O)	0	0~2048	The signal number for Layer count signal used by the palletize start function FN249.
Work count signal (O)	0	0~2048	The signal number for Work-piece count signal used by the palletize start function FN249.
Palletize end signal (O)	0	0~2048	The signal number for palletize completion signal used by the palletize end function FN250.
Hand open signal (O)	0	0~2048	An output signal to open the hand. When setting "0" here, a step that uses this signal will not be recorded in the program.
Hand open wait signal (I)	0	0~2048	An input signal to wait until the hand opens. When setting "0" here, a step that uses this signal will not be recorded in the program.
Hand close signal (O)	0	0~2048	An output signal to close the hand. When setting "0" here, a step that uses this signal will not be recorded in the program.
Hand close wait signal (I)	0	0~2048	An input signal to wait until the hand closes. When setting "0" here, a step that uses this signal will not be recorded in the program.
Work wait signal (I) (only for palletize)	0	0~2048	An input signal to wait for the work-piece. When setting "0" here, a step that uses this signal will not be recorded in the program.

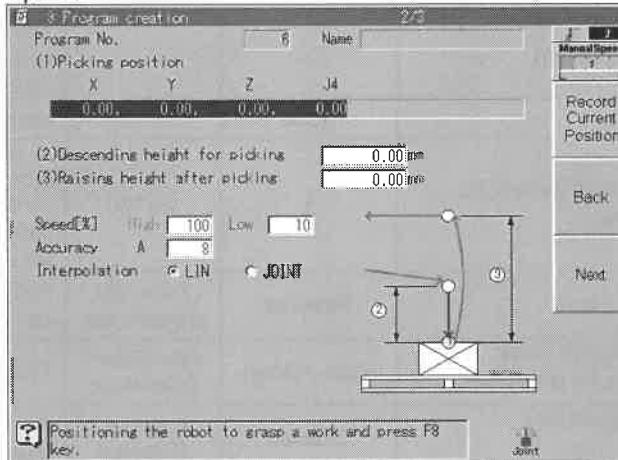
Item	Initial setting	Range	Description
Waiting to put a work (I) (only for de-palletize)	0	0~2048	An input signal to wait for a permission to put the Work-piece. When setting "0" here, a step that uses this signal will not be recorded in the program.

5.3.3 Picking position setting

- 1 Set the cursor to "(1)Picking position".
>>f8 Record Current Position> key will appear.



In case of de-palletize:



- 2 Move the robot to a position of picking a work-piece. (The 1st one on the 1st layer)

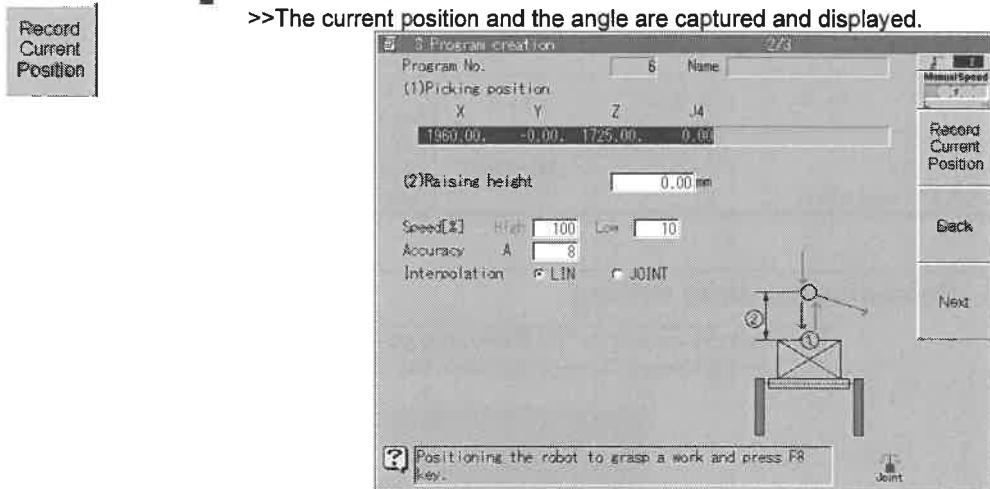
In case of de-palletizing program, put the robot to the position of the No.1 work-piece of the lowest Layer.

At this time,

- The manual operation speed can be changed with <f7 Manual Speed> key.
- The manual operation coordinate system can be changed with [INTERP/COORD.] key.

3 Press <f8 Record Current Position>

>>The current position and the angle are captured and displayed.

**4 Input the respective parameters and then press <F10 Next> key.**

For details of each parameter, refer to the following Table.

Table 5.3-2 Setting items in [Picking position setting] screen (Palletize)

Item	Initial setting	Range	Description
Program No.	---	---	The number of the program that is being edited. This number cannot be modified in this screen.
Name	----	----	The name of the program that is being edited. This name cannot be modified in this screen.
(1) Picking position	---	---	The position and the angle of a picking point are displayed here. It is not possible to edit the values directly in this screen. If <f8 Record Current Position> is pressed, the current position and the angle are captured and displayed.
(2) Raising height	0.0	0.0 - 9999.9	The raising height after grasping the work-piece.
Speed[%] High	100	1 - 100	Motion speed after grasping the work-piece. (red arrow)
Low	10	1 - 100	Motion speed to grasp the work-piece. (blue arrow)
Accuracy	8	1 - 8	Motion accuracy setting that is used after grasping the work-piece.
Interpolation (displayed on AXV08.011 and after)	LIN	LIN/JOINT	Selecting the motion from LIN(liner interpolation) or JOINT to move from the upper position of grasping point to the upper position of releasing point.

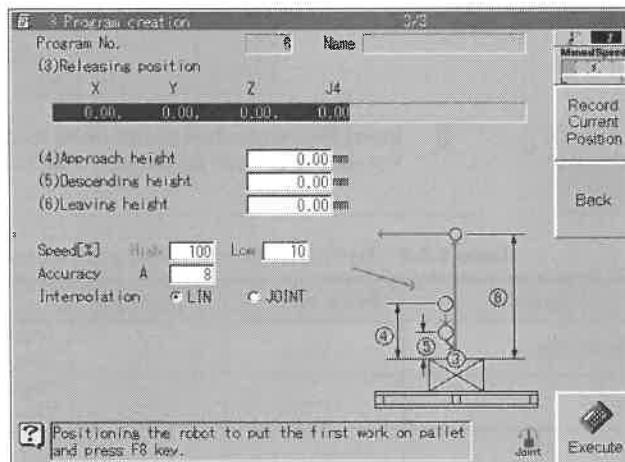
Table 5.3-3 Setting items in [Picking position setting] screen (De-palletize)

Item	Initial setting	Range	Description
Program No.	---	---	The number of the program that is being edited. This number cannot be modified in this screen.
Name	----	----	The name of the program that is being edited. This name cannot be modified in this screen.
(1) Picking position	---	---	The position and the angle of a picking point are displayed here. It is not possible to edit the values directly in this screen. If <f8 Record Current Position> is pressed, the current position and the angle are captured and displayed.
(2) Descending height for picking	0.0	0.0 - 9999.9	The height where the deceleration starts before grasping the work-piece.
(3) Raising height after picking	0.0	0.0 - 9999.9	The raising height after grasping the work-piece.
Speed[%] High	100	1 - 100	Motion speed that is used before/after grasping the work-piece. (red arrow)

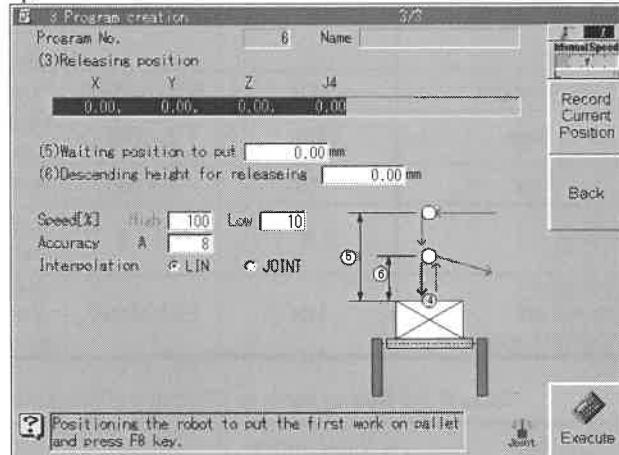
Item	Initial setting	Range	Description
Low	10	1 - 100	Motion speed that is used right before grasping the work-piece. (blue arrow)
Accuracy	8	1 - 8	Accuracy setting that is used after grasping the work-piece.
Interpolation (displayed on AXV08.011 and after)	LIN	LIN/JOINT	Selecting the motion from LIN(liner interpolation) or JOINT to move from the upper position of grasping point to the upper position of releasing point.

5.3.4 Releasing position setting

- 1 Set the cursor to "(1) Releasing position".
 >><f8 Record Current Position> key will appear.



In case of de-palletize:



- 2 Move the robot to a position of placing a work-piece. (The 1st one on the 1st layer)

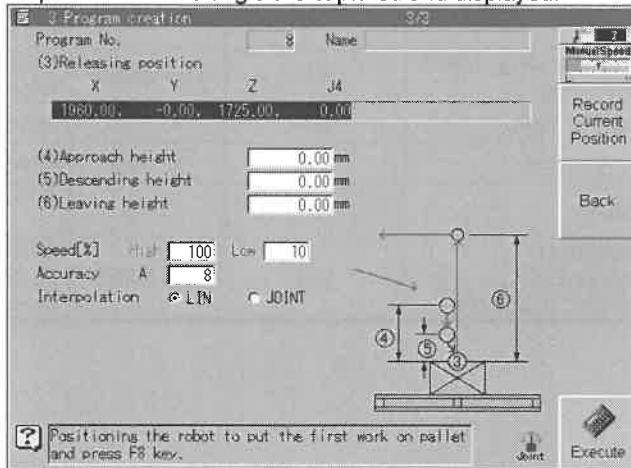
In case of de-palletizing program, put the robot to the position of the No.1 work-piece of the lowest Layer.

At this time,

- The manual operation speed can be changed with <f7 Manual Speed> key.
- The manual operation coordinate system can be changed with [INTERP/COORD.] key.

Record
Current
Position

- 3 Press <f8 Record Current Position>**
>>The current position and the angle are captured and displayed.



Next

- 4 Set the respective parameters and then press <f12 Execute> key.**
>>A program will be generated automatically.
If error messages are displayed, follow the displayed instructions.
For details of each parameter, refer to the following Table.

Table 5.3-4 Setting items in [Releasing position setting] screen (Palletize)

Item	Initial setting	Range	Description
Program No.	---	---	The number of the program that is being edited. This number cannot be modified in this screen.
Name	---	---	The name of the program that is being edited. This name cannot be modified in this screen.
(3) Releasing position	---	---	The position and the angle of a releasing point for the 1st work-piece are displayed here. It is not possible to edit the values directly in this screen. If <f8 Record Current Position> is pressed, the current position and the angle are captured and displayed.
(4) Approach height	0.0	0.0~9999.9	The height where approaching motion is started.
(5) Descending height	0.0	0.0 - 9999.9	The height where loading motion is started after approaching.
(6) Leaving height	0.0	0.0 - 9999.9	The height where taking shelter after releasing work-piece.
Speed[%] High	100	1 - 100	Motion speed that is used after approach and putting the work-piece. (red arrow)
Low	10	1 - 100	Motion speed that is used when putting the work-piece. (blue arrow)
Accuracy	8	1 - 8	Accuracy that is used after approach and putting the work-piece.
Interpolation (displayed on AXV08.011 and after)	LIN	LIN/JOINT	Selecting the motion from LIN(liner interpolation) or JOINT to move from the upper position of releasing point to the upper position of grasping point.

Table 5.3-5 Setting items in [Releasing position setting] screen (De-palletize)

Item	Initial setting	Range	Description
Program No.	---	---	The number of the program that is being edited. This number cannot be modified in this screen.
Name	---	---	The name of the program that is being edited. This name cannot be modified in this screen.
(3) Releasing position	---	---	The position and the angle of a releasing point for the 1st work-piece are displayed here. It is not possible to edit the values directly in this screen. If <f8 Record Current Position> is pressed, the current position and the angle are captured and displayed.

Item	Initial setting	Range	Description
(5) Waiting position to put	0.0	0.0 - 9999.9	Position that robot waits a signal for permission to put a work.
(6) Descending height for releasing	0.0	0.0 - 9999.9	Height that robot begins deceleration to the releasing position.
Speed[%] High	100	1 - 100	Motion speed to move the work-piece. (red arrow)
Low	10	1 - 100	Motion speed to place the work-piece.(blue arrow)
Accuracy	8	1 - 8	Accuracy to move the work-piece.
Interpolation (displayed on AXV08.011 and after)	LIN	LIN/JOINT	Selecting the motion from LIN(liner interpolation) or JOINT to move from the upper position of releasing point to the upper position of grasping point.

5.3.5 Modifying the created program

It is possible to modify the contents of the created program.

But if the program was modified using screen editor or normal teaching operations, there are some cases where the program cannot be loaded using this menu.

In the steps of a program that was created using this menu, comment data to show the meaning of the step is recorded. (Refer to Fig. 5.3.1-3, Fig 5.3.1-4)

When loading the program, the comment data and the contents of the step are compared and their consistency will be checked.

Table 5.3-6 Consistency check for the step data

Check item	Process for loading	Process for saving (after loading)
There is no step for signal output.	The program is loaded regarding the signal setting is "0".	
There are some steps that have no relationship with this "Program creation" menu.	Steps manually inserted are ignored when loading the program.	Those steps will remain after saving the program.
There is an inconsistency between the step comment and the contents of the move command.	A confirmation message for continuing the loading process will be displayed. If the loading process is continued, the setting values of those step comments will be displayed.	The concerned steps will be overwritten with move commands that are newly generated based on the setting value.
A value for certain parameter originally shared in several steps has been modified and is different each other in those steps.	A confirmation message for continuing the loading process will be displayed. If the loading process is continued, a parameter of a step whose step number is the smallest among the concerned steps is used as a valid setting value.	The setting values for the parameter of the 2nd step and the steps following the 2nd step will be overwritten with the setting value.
There are plural step comments that are the same each other.	A confirmation message for continuing the loading process will be displayed. If the loading process is continued, a step of which the step number is the smallest is recognized as a valid step.	The following steps will be deleted.

But in cases listed as below, the loading process will be aborted.

- There is an inconsistency between the step comment and the contents of the step.
- The following functions do not exist in the program.

Palletize PALLTIZE START (FN249)

PALLETIZE END (FN250)

APPROACH SELECTION (FN374)

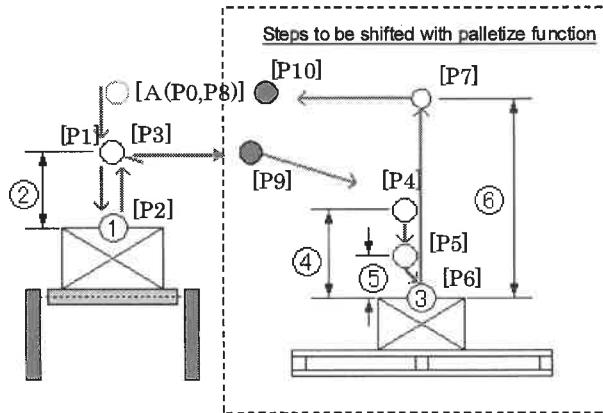
De-palletize PALLTIZE START (FN249)

PALLETIZE END (FN250)

5.4 Another creating program

5.4.1 Palletize optimize path

An example of "FN375 Palletize optimize path" is shown as below.



1	REM	Program name
2	*TOP	
3	RESET [O1]	
4	SET[O2]	
5	100% LIN A8 T2	Move to P1
6	WAITI[I3]	
7	WAITI[I2]	
8	30% LIN A1P T2	Move to P2
9	RESET[O2]	
10	SET[O1]	
11	WAITI[I1]	
12	100% LIN A8 T1	Move to P3
13	PALLET3[1,0,O10,O20]	PALLETIZE
14	PALLET3_AP[1,1]	APPROACH ON
15	PALLET3_OPT[1,17]	Optimize path (Reference step : 17)
16	100% LIN A8 T1	Move to P9 (NOTE1)
17	100% LIN A8 T1	Move to P4
18	100% LIN A8 T1	Move to P5
19	30% LIN A1P T1	Move to P6
20	RESET[O1]	
21	SET[O2]	
22	100% LIN A8 T2	Move to P7
23	PALLET3_OPT[1,26]	Optimize path (Reference step : 26)
24	100% LIN A8 T1	Move to P10 (NOTE2)
25	PALLET3_END[1,O30]	PALLETIZE FINISH
26	100% LIN A8 T2	Move to P8
27	GOTO *TOP	To the loop top
28	END	

(NOTE1)

The height (=Z coordinates of the pallet coordinate system) of P9 is optimized referring to the height of P3 and P4. (The higher Z is used)

(NOTE2)

The height (=Z coordinates of the pallet coordinate system) of P10 is optimized referring to the height of P7 and P8. (The higher Z is used)

5.4.2 Palletize select grasp position

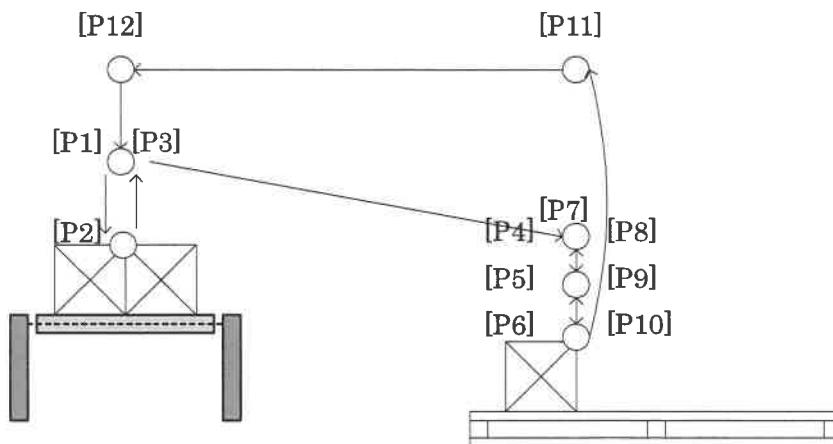
An example of "FN376 Palletize select grasp position" is shown as below. This is an example in which 2 work-pieces are picked up and are placed onto the pallet one by one.

Please make (record) a path for placing a work-piece twice using points that are the same. ([P4, 6] and [P8, 9, 10]) The teaching should be made based on the 1st work-piece.

Just after starting the 1st palletizing, set the grasp position 1 using PALLET3_SELGR command.

After placing the 1st work-piece, execute PALLET3_END to increment the work-piece counter.

And then before placing the 2nd work-piece, start the palletizing again using PALLET3. And set the grasp position 2 using PALLET3_SELGR command.



1	REM[]	Program name
2	RESET [O1]	"Hand 1 close" signal OFF
3	RESET [O3]	"Hand 2 close" signal OFF
4	SET[O2]	"Hand 1 open" signal ON
5	SET[O4]	"Hand 2 open" signal ON
6	*TOP	
7	100% LIN A8 T2	Move to P1
8	WAITI[I5]	Wait "waiting for a work-piece" signal
9	WAITI[I2]	Wait "Hand 1 open" signal
10	WAITI[I4]	Wait "Hand 2 open" signal
11	30% LIN A1P T2	Move to P2
12	RESET[O2]	"Hand 1 open" signal OFF
13	RESET[O4]	"Hand 2 open" signal OFF
14	SET[O1]	"Hand 1 close" signal ON
15	SET[O3]	"Hand 2 close" signal ON
16	WAITI[I1]	Wait "Hand 1 close" signal
17	WAITI[I3]	Wait "Hand 2 close" signal
18	100% LIN A8 T1	Move to P3
19	PALLET3[1,0,O10,O20]	Palletize start
20	PALLET3_SELGR[1]	Set the grasp position "1"
21	PALLET3_APP[1,1]	Approach ON
22	100% LIN A8 T1	Move to P4
23	100% LIN A8 T1	Move to P5
24	30% LIN A1P T1	Move to P6
25	RESET[O1]	"Hand 1 close" signal OFF
27	SET[O2]	"Hand 1 open" signal ON
28	100% LIN A8 T2	Move to P7
29	PALLET3_END[1,O30]	Palletize end
30	PALLET3[1,0,O10,O20]	Palletize start
31	PALLET3_SELGR[2]	Set the grasp position "2"
32	PALLET3_APP[1,1]	Approach ON
33	100% LIN A8 T1	Move to P8
34	100% LIN A8 T1	Move to P9

35	30% LIN A1P T1	Move to P10
36	RESET[O3]	"Hand 2 close" signal OFF
37	SET[O4]	"Hand 2 open" signal ON
38	100% LIN A8 T2	Move to P11
39	PALLET3-END[1,O30]	Palletize end
40	100% LIN A8 T2	Move to P12
41	GOTO *TOP	To the *TOP
42	END	

Chapter 6 Convenient functions

This chapter describes special functions or convenient functions that can be used for the motion check.

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6.3.2 FN378 Set palletize register	6-6

6.1 Shortcut

6.1.1 R377 Palletize counter reset

The palletize counters for the palletize task which is designated via the parameter will be reset. (Both of the Layer counter and the Work-piece counter will be set to "0") It is also possible to reset the counters of the all palletize tasks.

Item	Contents	Setting range
Palletize No.	Input the number of the palletize task to reset. If "0" is set, the all palletize tasks will be reset.	From 1 - 100 (0:All palletize tasks)

6.1.2 R378 Change palletize counter

The value of a palletize counter can be set to any desired value.

Item	Description	Setting range
Palletize number	Set the number of the palletize task of which the counter is to be changed.	From 1 to 100
Layer counter	Set a new Layer number.	From 1 to 50
Work-piece counter	Set a new Work-piece number.	From 1 to 99

6.1.3 R379 Execution palletize forcibly

Applicable on the software version AXV08.011 and after.

This can change the palletizing status to "ongoing" while robot is stopping. This is the same status after FN249 Palletize start is executed.

Also palletizing counter can be changed as wanted.

Item	Description	Setting range
Palletize number	Set the number of the palletize task of which the counter is to be changed.	From 1 to 100
Layer counter	Set a new Layer number.	From 1 to 50
Work-piece counter	Set a new Work-piece number.	From 1 to 99



IMPORTANT

When this R code is inputted and program playback is restarted, beware that immediately robot starts shift motion from the first move step.

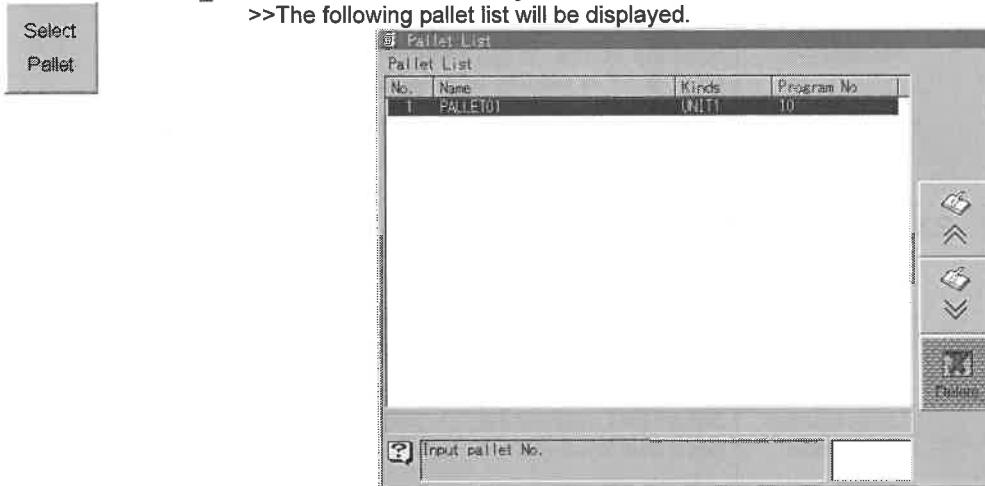
6.2 Function keys (Software keys)

6.2.1 Select Pallet

When operating the robot in manual mode, it is possible to change the operation coordinate system to the designated pallet coordinate system.

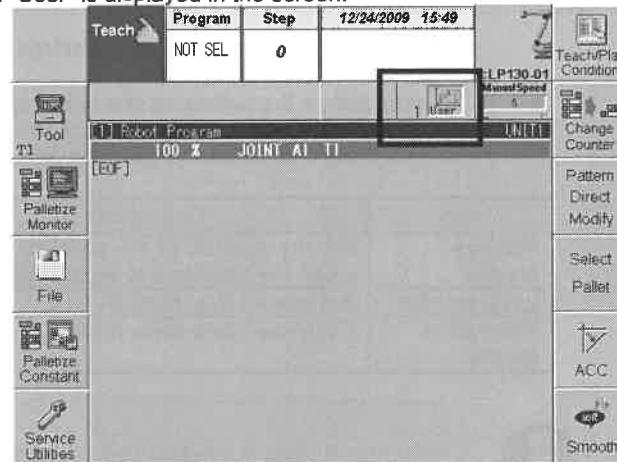
- 1 Press <Select Pallet> key.**

>>The following pallet list will be displayed.



- 2 Set the cursor to the desired pallet and press [Enter] key.**

>>The current coordinate system will be switched to the designated pallet coordinate system and "User" is displayed in the screen.

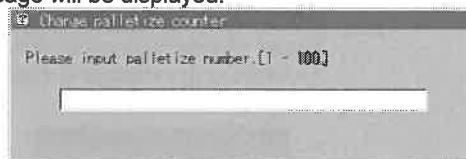


6.2.2 Change Palletize Counter

It is possible to set any desired value to the palletize counter.

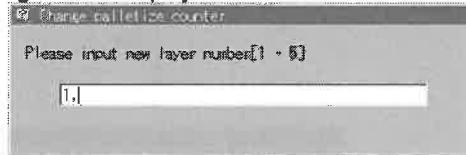
- 1 Press <Change Counter> key.

>>A following message will be displayed.



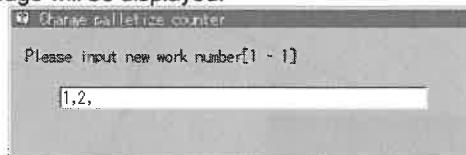
- 2 Input a palletize pattern number and then press [Enter].

>>A following message will be displayed.



- 3 Input a new layer number and press [Enter].

>>A following message will be displayed.



- 4 Input a new work-piece number and press [Enter].

>>The inputted values are set to the palletize counter.

The values can be confirmed using Palletize monitor.

Concerning the palletize monitor, see the Chapter 7.

6.2.3 Palletize direct modification

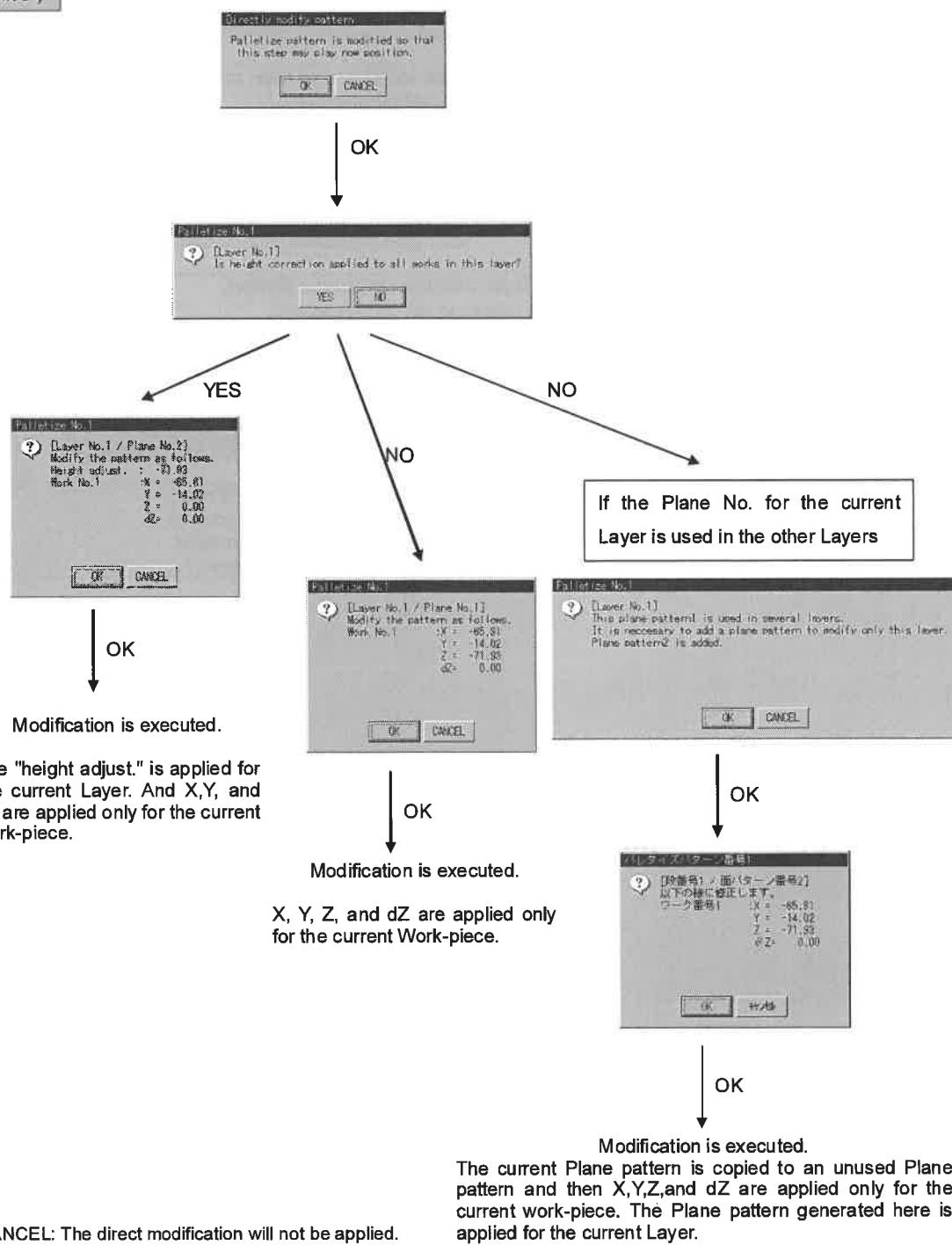
It is possible to modify the palletize pattern directly by adjusting the robot position to the work-piece in manual operation.

Pattern
Direct
Modify

- I Stop the robot while the palletizing is being executed and manually move the robot to a position where the work-piece is to be placed.**

Press <Pattern Direct Modify> key.

>>A following message is displayed. Please follow the diagram shown as below.



6.3 Special functions

6.3.1 FN377 Get palletize register

"Palletize registers" are internal variables to manage the status of the palletize function. Normally it is not necessary to handle those values by yourself because the system software handles them. But by reading/ modifying those values, it becomes possible to build a complex motion.

[Example]

- Change the robot's motion path by referring to the current value of the palletize counter
- Skip the counter intentionally for a certain purpose.
- Modify the shift amount.

This application command is a command to copy the value of a palletize register to a desired variable of the controller. To write the modified value back to the register, please use " FN378 PALLET_SETREG".

Mnemonic	Number	Command
PALLET3 GETREG	FN377	Get palletize register
Parameter	Data	Description, setting range
1st parameter	Variable No. Select from V!, V%, L! or L%	Target variable No. to store value Select from V!, V%, L! or L%
2nd parameter	Palletize No.	This specifies the palletizing number to be executed. (1 to 100)
3rd parameter	Register type (Start)	Set number of Palletize Registers(1 - 255) (1 to 16)
4th parameter	Register type (End)	Set number of Palletize Registers(1 - 255) (1 to 16) You can select and get consecutive register values from Start to End

Table 6.3-1 Register list

No.	Register name	Description	Type	Range	Permitted to be over-written
1	Palletize No.	Target palletize No.	Int.	1~100	
2	Pallet No.	Target pallet No.	Int.	1~100	
3	Running status	Stop or Running	Int.	0/1	
4	Type	Palletizing or De-palletizing	Int.	0/1	○
5	Layer counter	Layer No. in running	Int.	0~50	○
6	Work counter	Work No. in running	Int.	0~99	○
7	Total counter	Total work counter in running (Counting from the 1st work-piece of the 1st Layer)	Int.	0~4950	
8	Grasp position sel.	Work grasp position No. in use	Int.	1~4	○
9	Approach dir.	Approach direction in use	Int.	0~8	○
10	Layer count signal	LSB Signal No. of Layer count signal	Int.	0~1024	○
11	Work count signal	LSB Signal No. of work count signal	Int.	0~1024	○
12	Work complete signal	Work complete signal No.	Int.	0~1024	○
13	Shift value X	Current shift value of X axis based on the pallet coordinate	Real	—	○
14	Shift value Y	Current shift value of Y axis based on the pallet coordinate	Real	—	○
15	Shift value Z	Current shift value of Z axis based on the pallet coordinate	Real	—	○
16	Shift value Rz	Current shift value of Rz axis based on the pallet coordinate	Real	—	○

6.3.2 FN378 Set palletize register

"Palletize registers" are internal variables to manage the status of the palletize function. Normally it is not necessary to handle those values by yourself because the system software handles them. But by reading/ modifying those values, it becomes possible to build a complex motion.

[Example]

- Change the robot's motion path by referring to the current value of the palletize counter
- Skip the counter intentionally for a certain purpose.
- Modify the shift amount.

This application command is a command to copy a value of a desired variable of the controller to a specified palletize register. To copy a value in a register to the controller's variable, please use "FN377 PALLET_GETREG".

■ In case of using software version AXV08.011 and after

Some register is permitted to be over-written, but some is not. Please refer to the table 6.3-1 register list for detail.

If registers not permitted to be over-written, alarm is not generated but register is not changed.

Mnemonic	Number	Command
PALLET3_SETREG	FN378	Set palletize register

Parameter	Data	Description, setting range
1st parameter	Palletize No.	This specifies the palletizing number to be executed. (1 to 100)
2nd parameter	Register type (Start)	Set number of Palletize Registers(1 - 255) (1 to 16)
3rd parameter	Register type (End)	Set number of Palletize Registers(1 - 255) (1 to 16) You can select and write to consecutive registers from Start to End.
4th parameter	Variable No.	Target variable No. to store value Select from V!, V%, L! or L%



CAUTION

The value of the palletize registers affects the motion of the robot. Pay special attention not to change their values carelessly.



INFO.
Only by changing of "layer counter" and "work counter", shift amount is not changed.
When "FN249 Palletize start" is executed, new shift amount is calculated in accordance with the current counter.

To switch the work grasping position using the work-piece number, get the current work-piece number to a V% variable etc. using "FN377 PALLET3_GETREG" and make the program so that a suitable "FN376 PALLET3_SELGR" is executed via e.g. "SWITCH" flow control command etc.

Chapter 7 Motion checks and operation

This chapter describes the useful functions that are available during the motion checks or automatic operations.

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7.1.2 How to modify the palletize counter	7-2

7.1 Monitoring the current statuses

7.1.1 How to display the palletize counter monitor

In this palletize function, it is possible to execute several palletize pattern in parallel (Simultaneous palletizing / Multiple palletizing). Using "Palletize Monitor", it is possible to monitor which palletize pattern is handling which work-piece.

A variable that holds the number of the work-piece which is being handled is called as "Palletize counter (Work-piece)". And, a variable that holds the number of the Layer which is being handled is called as "Palletize counter (Layer)". When a new palletizing task is started, both of those 2 counter values are set to "1", and then they are incremented when executing "FN250 Palletize end". In short, at the start function (FN249), the value will show the number of the work-piece which will be loaded from now on and at the end function (FN250), the value will change to the value which show the number of the next work-piece.

When the palletizing task is finished completely, both of the Layer counter and the Work-piece counter will become "1"

The value of those counters can be monitored in real-time by the following operations.



1 Select Teach mode or Playback mode.

2 Press <Palletize Monitor> key.

>>A monitor screen for palletize counter will be displayed.

Palletize monitor				
No.	Pallet	Layer	Work	Name
1	1	1 / 5	1 / 8	Palletize01
2	1	1 / 3	2 / 8	Palletize02
3	1	0 / 4	0 / -	Palletize03

Item	Content
No.	This is a number of the palletize which is currently being executed. The all palletize patterns which are registered are displayed.
Pallet	This number shows which pallet (coordinate system) the concerned palletize pattern is using..
Layer	The current Layer number and the total number of the layers are displayed here. When not being executed, the display will be like "0 / Total number"
Work (Work-piece)	The current work-piece number of the current layer and the total number of the work-pieces of the layer. When not being executed, the display will be like "0 / -"

7.1.2 How to modify the palletize counter

The contents of the palletize counter can be modified using an editor mode of palletize monitor.

- 1 Press <Palletize Monitor> key.**

>>A monitor screen for palletize counter will be displayed.



No.	Pallet	Layer	Work	Name
1	1	1 / 5	1 / 9	Palletize01
2	1	1 / 3	2 / 9	Palletize02
3	1	0 / 4	0 / -	Palletize03

- 2 Press [EDIT] key.**

>>The monitor screen will enter an editor mode.



No.	Pallet	Layer	Work	Name
1	1	1 / 5	1 / 9	Palletize01
2	1	1 / 3	2 / 9	Palletize02
3	1	0 / 4	0 / -	Palletize03

- 3 Select the Layer or Work-piece to be modified and then input the desired value.**

To abort the palletize function, set "0" for the Layer or Work and press "Complete". To enter palletize execution status from the not-executed status, set a value except for "0" both to Layer and Work.

- 4 Press <f12 Complete> key.**

>>The counter is changed.



No.	Pallet	Layer	Work	Name
1	1	1 / 5	1 / 9	Palletize01
2	1	0 / 3	0 / -	Palletize02
3	1	1 / 4	5 / 9	Palletize03

Chapter 8 Troubleshooting

In this chapter, troubleshooting related to the palletize function is described.

8.1 Trouble shooting 8-1

8.1 Trouble shooting

No.	A2201 (Alarm)
Message	Palletize-end does not follow Palletize function.
Cause	This error is detected when "FN249 Palletize start" and "FN250 Palletize end" functions are not executed in an correct combination/order.
Countermeasure	Please check if these 2 functions are recorded in a correct order. If there is an incorrect step, correct the program. When this error is detected even if the recorded steps (Palletize start and end) look correct, because it is assumed that the execution status of the palletize start and palletize end are conflicting, execute "R0 Reset & step 0 return" to cancel the confliction.
No.	A2202 (Alarm)
Message	More than 32 Palletizing routines not allowed.
Cause	When palletizing of 32 or more is executed at the same time, this error is detected.
Countermeasure	Terminate the unnecessary palletize by using "R377 Palletize counter reset" or "R378 Change Palletize counter" shortcuts.
No.	A2203 (Alarm)
Message	Palletize data is abnormal.
Cause	[FN249 palletize start] function calculates the shift amount using palletize data. This error is detected when the calculation result was incorrect. The reason is assumed that the necessary data for the calculation is not set yet.
Countermeasure	Please refer to palletize data.
No.	A2204 (Alarm)
Message	Multiplex palletize over.
Cause	This error occurs when multiplex palletize over 8 is carried out.
Countermeasure	Modify the program so that the number of the multiplex palletize does not exceed 8. Or, finish an unnecessary palletize by using "R377 Palletize counter reset" or "R378 Change Palletize counter" shortcuts.
No.	A2173 (Alarm)
Message	Shift value limit exceeded.
Cause	Not only in case of palletize motion, when the robot tries to move with shift motion exceeding the "Shift limit" value, this error is detected.
Countermeasure	Check the "Shift limit" setting. Or, correct the palletize data so that the calculated shift amount does not make an impossible shift motion.
No.	A2861 (Alarm)
Message	The designated palletize No. is not registered.
Cause	The palletize pattern of designated number by function etc. is not defined.
Countermeasure	(1) Please use a registered palletize number. (2) Please register the palletize pattern of the number concerned.
No.	A2862
Message	Designated palletize number has never been executed yet.
Cause	Palletize status is registered in palletize register when executing it once, and maintained until it is reset. This operation cannot be done to a palletize number unregistered in the palletize register.
Countermeasure	(1) Please designate an already-executed palletize number. (2) Please execute the palletize of the designated number at least one time before doing this operation.

No.	A2863
Message	Designate a palletize number which is being executed.
Cause	This operation is available only for a palletize which is being executed.
Countermeasure	(1) Designate a palletize number which is being executed. (2) Please execute palletize of the designated number before doing this operation.

Part 2

Palletize function

	<p>The part which is to be read differs depending on the setting of [Constant Setting][12 Format and Configuration] [7 Application]</p> <p>In case of "Palletize", refer to "Part1:Advanced palletize function" In case of "Handling", refer to "Part2: Palletize function"</p>
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Chapter 7 Troubleshooting

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Chapter 1 Outline

The term "palletizing" refers to the task involved in arranging objects in an orderly manner. By merely teaching the loading (or unloading) operations for one workpiece and by specifying the number of workpieces and the way in which they are to be loaded (unloaded) and positioned, it is possible to teach the loading (or unloading) operations for all workpieces.

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1.1 What the palletize function does

1.1.1 Outline

The term "palletizing" refers to the tasks involved in arranging objects (hereafter referred to as workpieces) in an orderly manner. The palletize function of the AX control unit enables the loading (or unloading) operations for all workpieces to be easily taught merely by teaching the loading (or unloading) operations for one workpiece and by specifying the number of workpieces, and the way in which they are to be loaded (or unloaded) and positioned. Conversely, the term "depalletizing" refers to the tasks involved in unloading in sequence workpieces which have been loaded.

The AX control unit offers two methods to teach palletizing. One is the "simple palletizing" method which is extremely easy to teach, and the other is the "complex palletizing" method which can be applied to complex and many different patterns. Select the method which better suits the way in which the workpieces are to be arranged and loaded.

1.1.2 Simple palletizing

Simple palletizing is used when the workpieces will all be facing in the same direction and when the way in which they are to be loaded at each level is the same (bar loading or flat loading). It can even support simple offset loading.

The number of patterns supported by simple palletizing is fewer than with complex palletizing, but its advantage is that the teaching method is extremely easy.

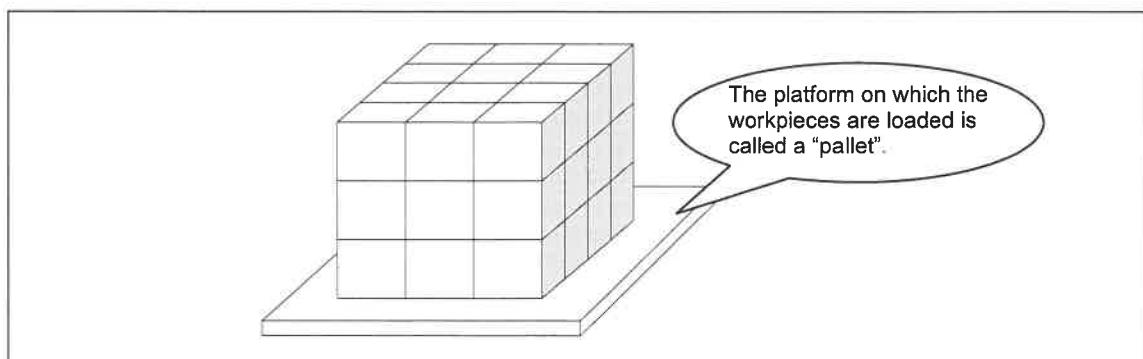


Fig. 1.1.1 Example of loading by simple palletizing

1.1.3 Complex palletizing

Complex palletizing is used when loading workpieces that come in shapes with different lengths along the left and right sides or when loading workpieces which are laid out in different directions at each row or on each level.

Compared with simple palletizing, complex palletizing requires many more data items to be set which makes the teaching more complicated, but it flexibly supports all kinds of loading methods which cannot be defined by simple palletizing.

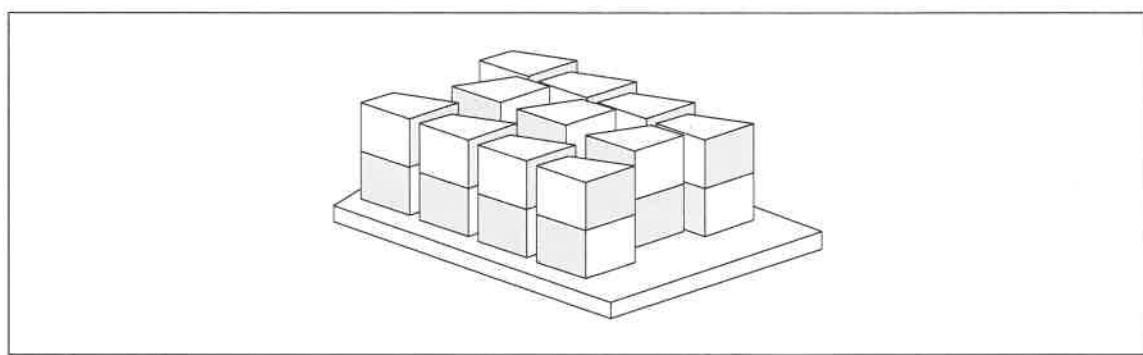


Fig. 1.1.2 Example of loading by complex palletizing

1.1.4 Frequently used terms

Brief definitions of some of the terms which are used by the palletizing function are given below.

Table 1.1.1 List of terms

Terms	Significance
Simple palletizing	This refers to a method of defining the palletizing of workpieces in predetermined patterns using simple data settings. The number of patterns supported by simple palletizing is fewer than with complex palletizing, but its advantage is that the teaching method is extremely easy.
Complex palletizing	This refers to a method of defining the palletizing of workpieces in different ways using detailed data settings. Compared with simple palletizing, complex palletizing requires many more data items to be set which makes the teaching more complicated, but it flexibly supports all kinds of loading methods which cannot be defined by simple palletizing.
Layout pattern	This term is used in connection with complex palletizing. It refers to the way in which the workpieces on one level are laid out. A complete palletizing pattern is established if these patterns are combined for the number of the load levels concerned.
Load level	This term is used in connection with complex palletizing. This refers to the number of levels created by stacking the workpieces on top of one other.
Palletize counter	This refers to the data that indicates the number of the workpiece which is now being processed in the palletizing task. It is useful as an indication of the progress made in the palletizing task.
Palletize table	This refers to the data that indicates the progress made in the palletizing task, and it is automatically generated by the software. It enables real-time monitoring during robot playback. While the robot is shut down, new data can be registered, old data can be deleted and the palletize counters can be preset.
Simultaneous palletizing	This refers to executing more than one palletizing task at the same time. (When one palletizing task ends, the next one begins.)
Multiple palletizing	This refers to executing another palletizing task while a palletizing task is already being performed. It involves adding each palletizing shift amount and performing the shift operations.
Depalletize	This refers to executing opposite operation of the palletizing.

1.1.5 Performance

Table 1.1.2 Specifications and performance of palletizing function

Terms	Significance
Simple palletizing	<ul style="list-style-type: none"> 100 patterns can be registered (using palletizing numbers 1 to 100). Workpieces can be loaded up to 50 load levels.
Complex palletizing	<ul style="list-style-type: none"> 100 patterns can be registered (using palletizing numbers 101 to 200). Workpieces can be loaded up to 50 load levels.
Layout pattern	<ul style="list-style-type: none"> 100 patterns can be registered. (The information on how the workpieces are to be laid out on each level as used by complex palletizing is set.)
Number of simultaneous palletizing operations	<ul style="list-style-type: none"> Up to 32 palletizing operations can be executed at the same time. The status of these operations while they are being executed can be monitored by the palletizing monitor.
Number of multiple palletizing operations	<ul style="list-style-type: none"> Up to 8 multiple operation
Other	<ul style="list-style-type: none"> Simple palletizing and complex palletizing can be combined in operations. The maximum number of workpieces which can be loaded by a single palletizing operation is 999. Using the palletize counter preset function, additional workpieces can be registered, specific workpieces can be preset and the palletizing operation now being executed can be deleted.

1.2 Task stages from teaching to operation

This section describes the work flow up to the stage where the robot executes the palletizing (or depalletizing) task.

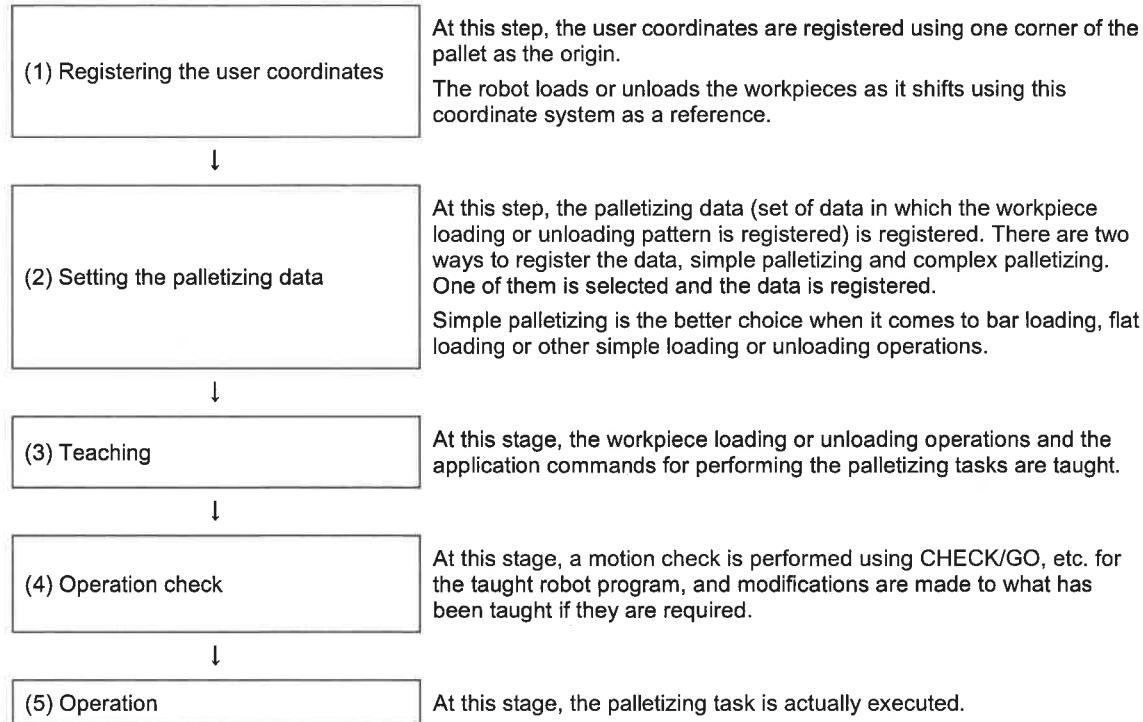


Fig. 1.2.1 Tasks from teaching to operation

1.2.1 Registering the user coordinates

Since it is by shifting based on the user coordinate system that the palletizing operations are achieved, this user coordinate system which serves as a reference must be registered ahead of time.

Register the user coordinates where one corner of the pallet which will be used to load the workpieces serves as the user coordinate origin.

Open [Service Utilities][10 User Coord. Definition] screen to register the user coordinates.

1.2.2 Setting the palletizing data

"Palletizing data" refers to the set of data in which the workpiece loading and unloading patterns have been registered.

There are two ways to register the data, simple palletizing and complex palletizing, so decide which option to select. Simple palletizing is easy to teach so select it when it comes to bar loading, flat loading or other simple loading or unloading operations.

Up to 100 simple palletizing patterns and up to 100 complex palletizing patterns can be registered.
Open [Constant Setting][17 Handling Application] screen to set the palletizing data.

For further details, refer to chapters 2 and following.

1.2.3 Teaching

The application commands (functions) are used for palletizing.

The palletizing tasks can be carried out by the robot simply by recording the "grip /E release" operation for the first workpiece and then recording the application commands, namely, "FN47 Palletize start" and "FN48 Palletize end."

For further details, refer to chapters 2 and following.

Execute every palletizing operation with one palletize start command and one palletize end command which is paired with the start command. (This does not apply to the "FN65 Direction select palletize" command.)

1.2.4 Motion check and initiating operation

Check the prepared robot program using CHECK/GO or 1-step playback, ascertain whether the robot will be performing the desired operations and, if necessary, modify what has been taught.

Upon completion of the motion check of the robot program, actually play back the program in the 1-cycle or continuous playback mode.

The steps taken to monitor the number of the workpiece currently being palletized or resume operation starting with an interim workpiece after an unexpected interruption to the previous operation are described in chapters 2 and following.

Chapter 2 Setup

This chapter describes the setup procedure for using the palletizing function.

2.1 Setup	2-1
2.2 Input/output signals dedicated to palletizing	2-2
2.2.1 Palletize end output signal	2-2
2.2.2 Palletize acknowledge output signal	2-2
2.2.3 Palletize counter value output signal	2-2

2.1 Setup

The palletizing function is provided in an optional software program. It cannot be used unless it is specified prior to shipment from the factory.

"Material handling" must be selected as the application setting. If the palletizing function option is specified, it is set prior to shipment from the factory, so no changes need to be made to the settings.

This is all that the setup entails: no other special setup work for using the palletizing function is required.

2.2 Input/output signals dedicated to palletizing

2.2.1 Palletize end output signal

This output signal is used exclusively by the palletizing function.

It indicates that palletizing has been completed (the pallet is fully loaded). Use it to check that the workpiece loading or unloading task has been completed successfully.

There is no need to allocate it: a general-purpose output signal is specified directly in the "FN48 Palletize end" application command and output.

2.2.2 Palletize acknowledge output signal

This output signal is used exclusively by the palletizing function.

It outputs the fact that the palletizing has been forcibly ended to an external device. Use it as the signal that confirms that the workpiece loading or unloading task has been forcibly ended.

There is no need to allocate it: a general-purpose output signal is specified directly in the "FN49 Palletize reset" application command and output.

The palletize acknowledge signal is set to ON when the "FN49 Palletize reset" command is executed. Two options are available as the condition for setting it to ON. Refer to the operating steps described in the next section.

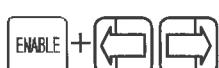
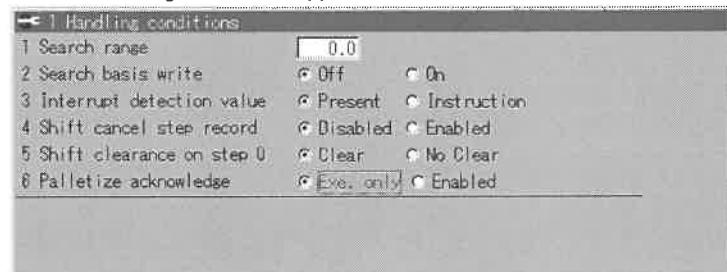
Setting the palletize acknowledge signal output condition

1 Select the [TEACH] mode



2 Open [Service Utilities][22 Handling Application][1 Handling conditions] screen.

>> The following screen will appear.



3 Align the cursor with "6 Palletize acknowledge", and check one of the radio buttons using [ENABLE] key and [Left] or [Right] cursor key.

Parameter	Description
Exe. Only	The signal is output only when the input condition established by the "FN49 Palletize reset" command is satisfied and the palletize counter has been reset.
Enabled	The signal is always output when the "FN49 Palletize reset" command has been executed regardless of whether the palletize counter is reset.



4 Press f key <Complete>, and exit [1 Handling conditions] screen.

2.2.3 Palletize counter value output signal

It is an output signal only for the palletize function.

This signal can in real time output the palletize counter value in the binary.

Refer to "3.2.3 Defining how to load (or unload) using simple palletizing", "4.4 Setting the complex palletizing data" for details.

Chapter 3 Simple palletizing

This chapter describes how to perform the settings to define the palletize data using simple palletizing.

3.1 Deciding whether to use simple palletizing or complex palletizing.....	3-1
3.2 Simple palletizing.....	3-1
3.2.1 Outline	3-1
3.2.2 Registering the user coordinates	3-1
3.2.3 Defining how to load (or unload) using simple palletizing	3-2

3.1 Deciding whether to use simple palletizing or complex palletizing

The operator must first decide whether to use simple palletizing or complex palletizing.

Simple palletizing has a narrower application range than complex palletizing, but its advantage is that the teaching method is extremely simple. Therefore, simple palletizing is used if the proposed operation can be managed by simple palletizing.

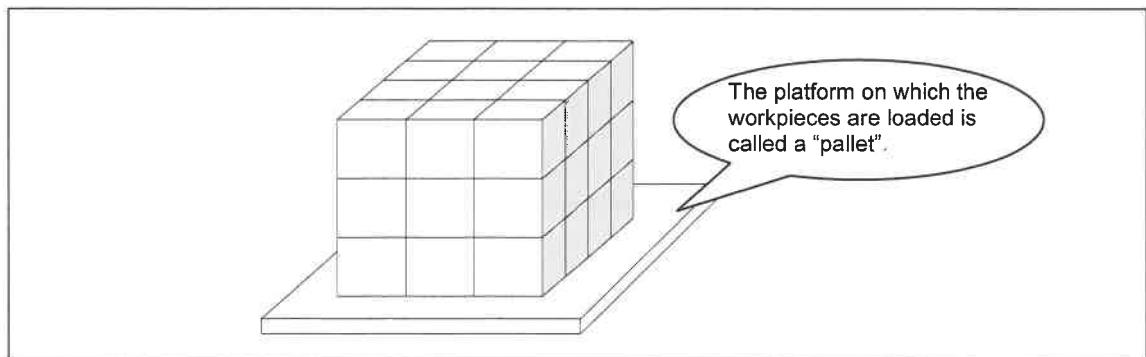


Fig. 3.1.1 Example of loading by simple palletizing

With simple palletizing, four patterns have been prescribed in advance for loading the workpieces. These patterns are shown in Fig. 3.1.2. Simple loading such as bar loading and flat loading constitutes the basic palletizing method. Simple offset loading can also be supported by specifying the "Offset" value.

Use simple palletizing if the workpiece loading method to be used is supported by one of the four prescribed patterns. If it is not supported by any of these patterns, use complex palletizing.

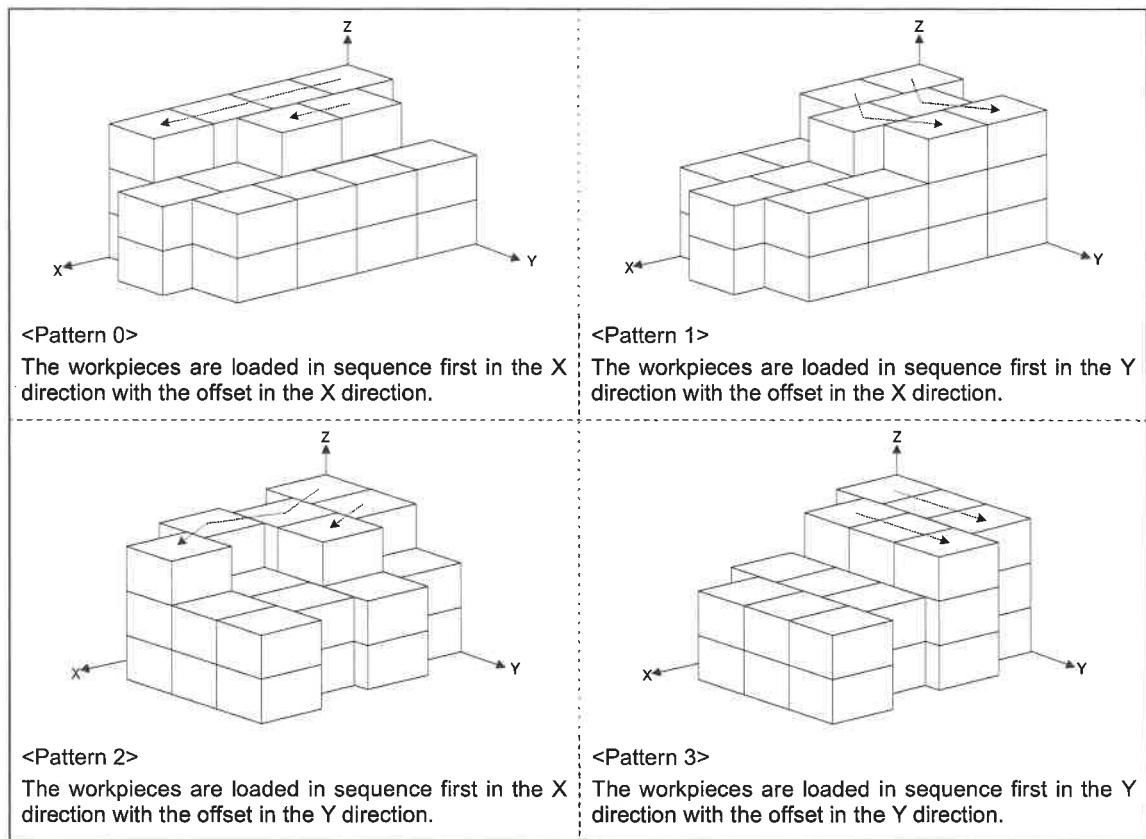


Fig. 3.1.2 Four simple palletizing patterns

3.1 Deciding whether to use simple palletizing or complex palletizing

Fig. 3.1.2 shows cases for each pattern where the offset amount has been set in "Offset."

For reference purposes, figures showing how the workpieces are loaded when 0 mm is set for "Offset" are provided below. This is the most straightforward form of flat loading.

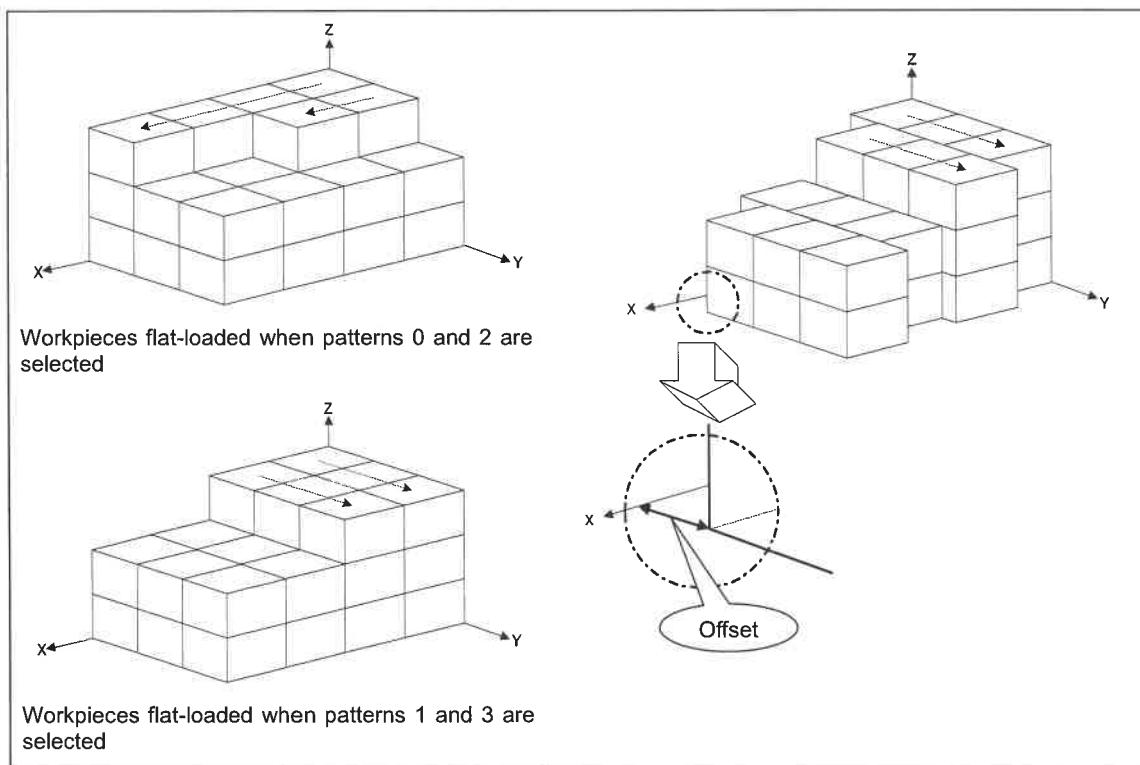


Fig. 3.1.3 Examples of most straightforward loading with simple palletizing based on an "Offset" setting of 0

3.2 Simple palletizing

3.2.1 Outline

With simple palletizing, the workpieces are stacked on each level according to the same straightforward pattern.

Simple palletizing has a narrower application range than complex palletizing, but its advantage is that the teaching method is extremely simple.

In total, a hundred palletizing patterns can be defined.

The set data is recorded in the simple palletizing data file (PALLET-SPL.CON).

The sequence of steps to be taken is described below.

3.2.2 Registering the user coordinates

Since it is by shifting based on the user coordinate system that the palletizing operations are achieved, this user coordinate system which serves as a reference must be registered ahead of time.

Register the user coordinates where one corner of the pallet which will be used to load the workpieces serves as the user coordinate origin.

The origin is recorded in such a way that a characteristic part such as the corner of the pallet or of the workpiece is brought into alignment with the tool tip position (TCP) of the robot. If the mechanical construction of the gripper is such that there is no part that indicates the TCP, attach an object with a sharp tip or take some other such step so that the TCP can be identified.

What are important about the user coordinates is their directions rather than the origin position.

The actual workpiece loading or unloading position is determined by this direction. From the position decided on as the origin, record the position correctly taken in the X (Y or Z) direction.

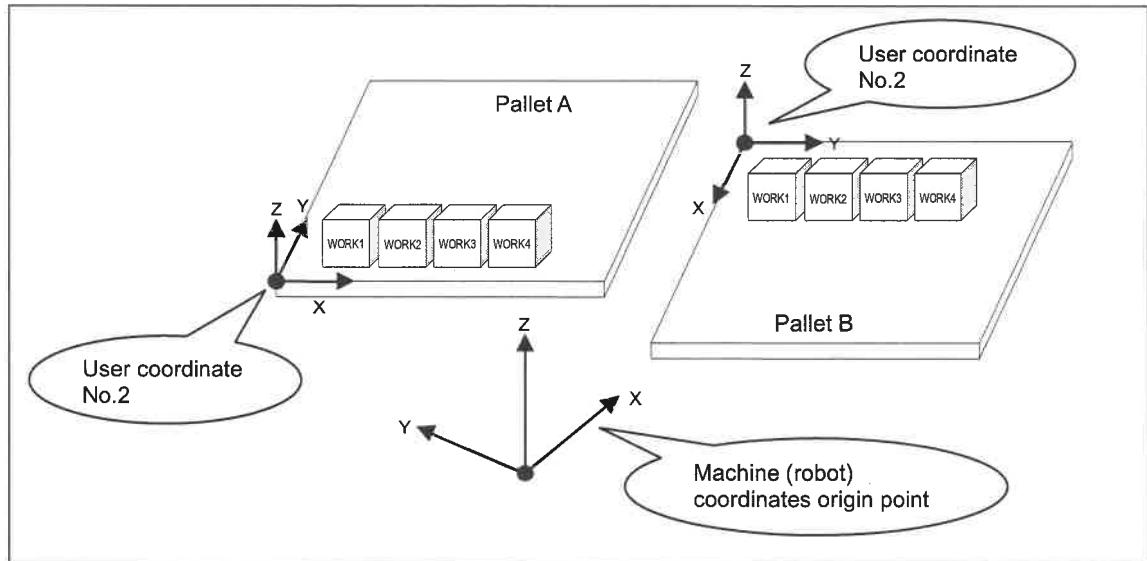


Fig. 3.2.1 User coordinate

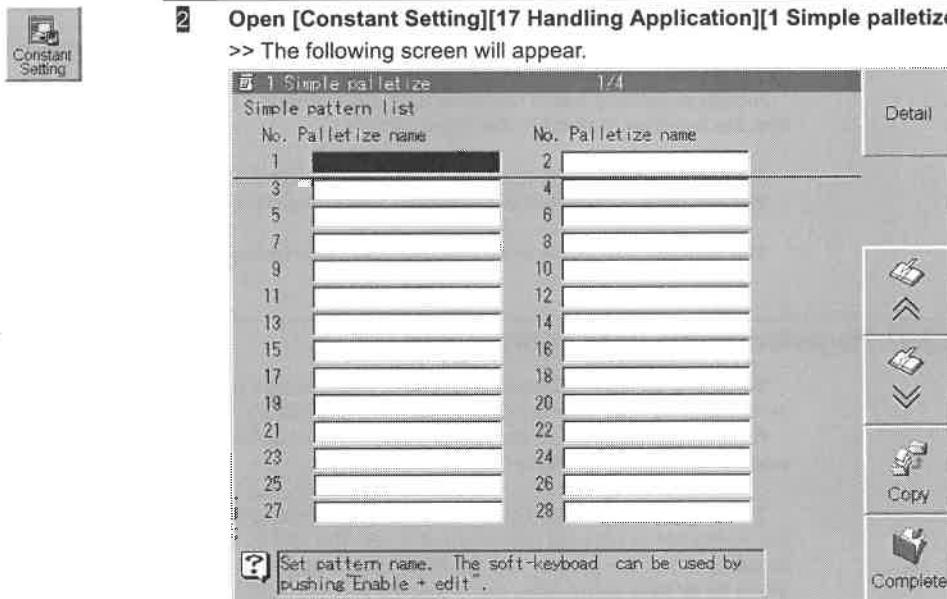
Open [Service Utilities][10 User Coord. Definition] screen to register the user coordinates. The operating steps will be skipped here.

3.2.3 Defining how to load (or unload) using simple palletizing

1 Select the [TEACH] mode

2 Open [Constant Setting][17 Handling Application][1 Simple palletize] screen.

>> The following screen will appear.

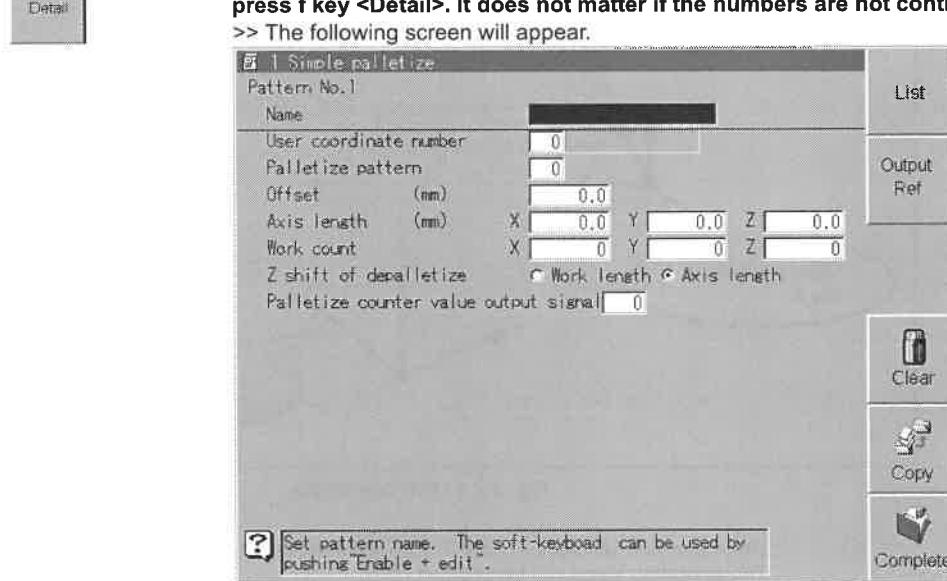


Up to 100 simple palletizing patterns can be registered. The numbers in the vertical columns are the numbers of these operations. For teaching, these numbers (palletizing numbers) are specified using the application commands.

When each detailed display screen is opened, a screen on which the pattern names, dimensions, and other detailed information are set appears.

3 Align the cursor to the name field of the palletizing number to be set, and press f key <Detail>. It does not matter if the numbers are not continuous.

>> The following screen will appear.



f key	Description
	Use this to return to the simple palletizing list screen.
	Use this to initialize all the data displayed.
	Use this to copy the displayed data into another palletizing number.

4 Align the cursor with the "Name", and register a unique name which is easy to identify.

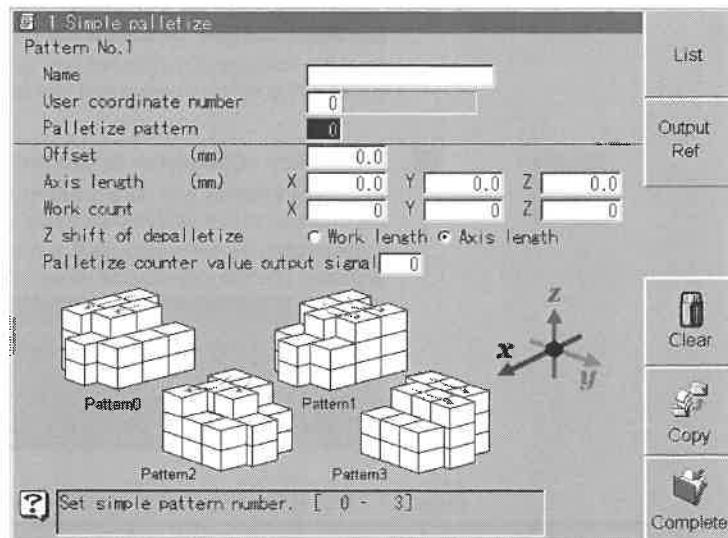
Open the soft keyboard by pressing [ENABLE] and [EDIT] keys, and input the name.

5 Align the cursor with the "User axis number", and input the number of the pre-defined user coordinates.

>> When the user coordinate number is set, the comment which is set for the corresponding user coordinate data is displayed. (Comments cannot be edited on this screen. A comment which has not been set will not be displayed.)

6 Align the cursor with "Palletize pattern", and input the number (0-3) to be used among the four prescribed simple patterns.

>> The data can easily be set since a pictorial guide appears at the bottom of the screen.



7 Align the cursor with "Offset," and set the offset amount by which the workpieces are to be offset when they are loaded. Straightforward flat loading will be selected if 0 mm is set as the "Offset" value.

For details on how to measure the offset dimension, refer to Fig. 3.1.3.

8 Align the cursor with "Axis length" and "Work count," and input the appropriate values while referring the figure below.

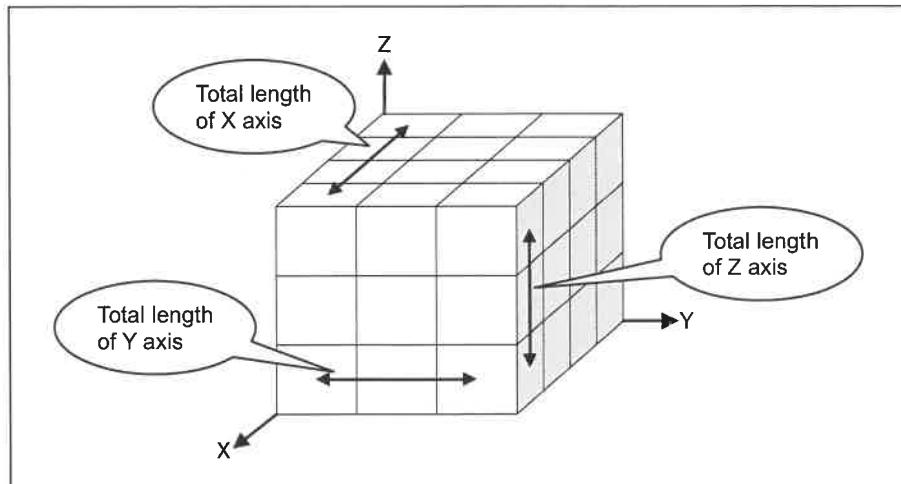


Fig. 3.2.2 Total length of axis and workpiece count

For instance, when square workpieces measuring 100 mm along each of their sides are loaded as shown in the figure, the values to be entered for "Axis length" and "Work count" will be as given below.

Axis length			Work count		
X	Y	Z	X	Y	Z
300	200	200	4	4	3

- 9 Align the cursor with "Palletize counter value output signal", and allocate the signal number to output the palletize counter value in the binary.
 >> If the first signal number of ten "palletize counter value output signal" is input, a consecutive signal number is automatically set to nine remainder.



- 10 Press f key <Complete> to exit the setting screen.

>> Check whether any data is still to be set, and if there are no problems, the data set is saved in the simple palletizing data file (PALLET-SPL.CON).
 If data still to be set is detected, a message such as the one shown below appears. Set the appropriate value, and perform the data save operation again.

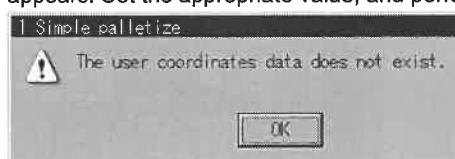
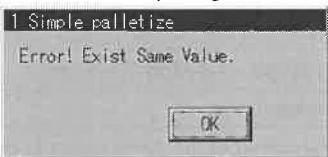


Table 3.2.1 List of simple palletizing setting parameters

Item	Description
Name	This is used to set a unique name for identifying simple palletizing. Setting range: 20 half-size characters (full-size characters may also be used) Initial value: Full-size/half-size space characters
User axis number	This is used to set the number of the user coordinate system used by the palletizing task. It must be registered on [Service Utilities][10 User Coord. Definition] screen in advance. Setting range: 1 to 100 Initial value: 0

Item	Description
Palletize pattern	<p>The four loading patterns shown in Fig. 3.1.2 are provided. Select which of the patterns is to be used for loading.</p> <p>Setting range: 0 to 3</p> <p>Initial value: 0</p>
Offset	<p>This is used to set the offset amount for offset loading. Straightforward flat loading will be selected if 0 mm is set as the "Offset" value. Refer to Fig. 3.1.3.</p> <p>Setting range: -1,000 to 1,000 mm</p> <p>Initial value: 0 mm</p>
Axis length	<p>With the corner of the pallet made to serve as the user coordinate origin, this parameter is used to specify the distance between the centers of both ends of the workpieces which have been laid out in each of the coordinate directions. It is used for automatically calculating the workpiece dimensions.</p> <p>(*) When setting a depalletize operation, please see the item "Z shift of depalletize" shown below.</p> <p>Setting range: 0 to 6,000 mm</p> <p>Initial value: 0 mm</p>
Work count	<p>With the corner of the pallet made to serve as the user coordinate origin, this parameter is used to specify how many workpieces are to be laid out in each of the coordinate directions. It is used for automatically calculating the total number of workpieces to be loaded on the pallet and the workpiece dimensions.</p> <p>(*) When setting a depalletize operation, set minus value for Z.</p> <p>Setting range: 1 to 99 for X, Y; -50 to 50 for Z</p> <p>Initial value: 0</p>
Z shift of depalletize (For setting this item, it is necessary to switch the operator class to Specialist or higher.)	<p>This is used to select the method to set the Z shift amount that is used when executing depalletize.</p> <p>Work length: The Z length (=height) of the workpiece is used for the Z axis length.</p> <p>Axis length: The length which ties the central point of the both ends of workpieces that are arranged along Z direction is used for the Z axis length. (This method is the same with palletize)</p> <p>Setting range: <Work length / Axis length></p> <p>Initial value: Axis length</p>

3.2 Simple palletizing

Item	Description																																																																					
<p>Palletize counter value output signal</p> <p>The signal to output the palletize counter value in the binary is allocated. If the first signal number of ten "palletize counter value output signal" is input, a consecutive signal number is automatically set to nine remainder, though ten output signals exist because the number that palletize is possible is up to 999. The following error messages are displayed when overlapping with other signals. Set it again after pushing f key <Output Ref>, and finding the signal number not used on the output signal screen.</p>  <p><Example> When "41" is set in "palletize counter value output signal" column, "42" ~ "50" of the remainder is set automatically. <u>When the palletize counter value is "5":</u> Because if "5" is shown by the binary it becomes "0101(2)", "41" and "43" are turned on, and "42" and "44" ~ "50" are turned off It is displayed in [User Outputs] monitor as follows.</p> <p>[2] Output Signal Monitor</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>0011</td><td>0012</td><td>0013</td><td>0014</td><td>0015</td><td>0016</td><td>0017</td><td>0018</td><td>0019</td><td>0020</td></tr> <tr><td>0021</td><td>0022</td><td>0023</td><td>0024</td><td>0025</td><td>0026</td><td>0027</td><td>0028</td><td>0029</td><td>0030</td></tr> <tr><td>0031</td><td>0032</td><td>0033</td><td>0034</td><td>0035</td><td>0036</td><td>0037</td><td>0038</td><td>0039</td><td>0040</td></tr> <tr><td>0041</td><td>0042</td><td>0043</td><td>0044</td><td>0045</td><td>0046</td><td>0047</td><td>0048</td><td>0049</td><td>0050</td></tr> <tr><td>0051</td><td>0052</td><td>0053</td><td>0054</td><td>0055</td><td>0056</td><td>0057</td><td>0058</td><td>0059</td><td>0060</td></tr> <tr><td>0061</td><td>0062</td><td>0063</td><td>0064</td><td>0065</td><td>0066</td><td>0067</td><td>0068</td><td>0069</td><td>0070</td></tr> <tr><td>0071</td><td>0072</td><td>0073</td><td>0074</td><td>0075</td><td>0076</td><td>0077</td><td>0078</td><td>0079</td><td>0080</td></tr> </table> <p>Setting range: 0 to 2039 Initial value: 0</p>	0011	0012	0013	0014	0015	0016	0017	0018	0019	0020	0021	0022	0023	0024	0025	0026	0027	0028	0029	0030	0031	0032	0033	0034	0035	0036	0037	0038	0039	0040	0041	0042	0043	0044	0045	0046	0047	0048	0049	0050	0051	0052	0053	0054	0055	0056	0057	0058	0059	0060	0061	0062	0063	0064	0065	0066	0067	0068	0069	0070	0071	0072	0073	0074	0075	0076	0077	0078	0079	0080
0011	0012	0013	0014	0015	0016	0017	0018	0019	0020																																																													
0021	0022	0023	0024	0025	0026	0027	0028	0029	0030																																																													
0031	0032	0033	0034	0035	0036	0037	0038	0039	0040																																																													
0041	0042	0043	0044	0045	0046	0047	0048	0049	0050																																																													
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0061	0062	0063	0064	0065	0066	0067	0068	0069	0070																																																													
0071	0072	0073	0074	0075	0076	0077	0078	0079	0080																																																													

Chapter 4 Complex palletizing

This chapter explains how to perform the settings when the palletizing data is to be defined using complex palletizing.

4.1 Outline	4-1
4.1.1 Outline of complex palletizing	4-1
4.1.2 Setting procedure for complex palletizing	4-2
4.2 Registering the user coordinates	4-3
4.3 Setting of "Locate pattern position" parameter	4-4
4.4 Registering the layout pattern	4-6
4.4.1 Procedure for defining workpiece position (in "Work Scale/Gap" mode)	4-6
4.4.2 Registering location pattern (in "Work Scale/Gap" mode)	4-10
4.4.3 Procedure for defining workpiece position (in "Shift value" mode)	4-13
4.4.4 Registering location pattern (in "Shift value" mode)	4-15
4.5 Setting the complex palletizing data	4-18
4.5.1 Setting of highly effective palletizing data (in "Work Scale/Gap" mode)	4-18
4.5.2 Setting of highly effective palletizing data (in "Shift value" mode)	4-22
4.6 Monitoring the loading status on the check display	4-25
4.7 Shift amounts	4-26

4.1 Outline

4.1.1 Outline of complex palletizing

By specifying any workpiece dimensions and any way of laying out the workpieces on each level (layout pattern), complex palletizing can achieve many different kinds of palletizing which are beyond what is offered by simple palletizing.

CAUTION

The "Shift value" mode can be used by AX control software versions later than AXV07.21.
AX control software versions earlier than AXV07.20 are only available for the "Work Scale/Gap" mode.

A total of 100 patterns can be defined with complex palletizing.
The data set is saved in the complex palletizing data file (PALLET-CPX.CON).

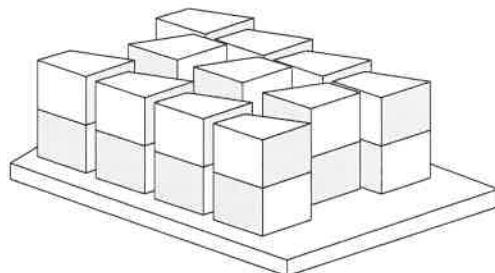


Fig. 4.1.1 Example of loading by complex palletizing

4.1.2 Setting procedure for complex palletizing

The steps taken to set the complex palletizing data are shown below.

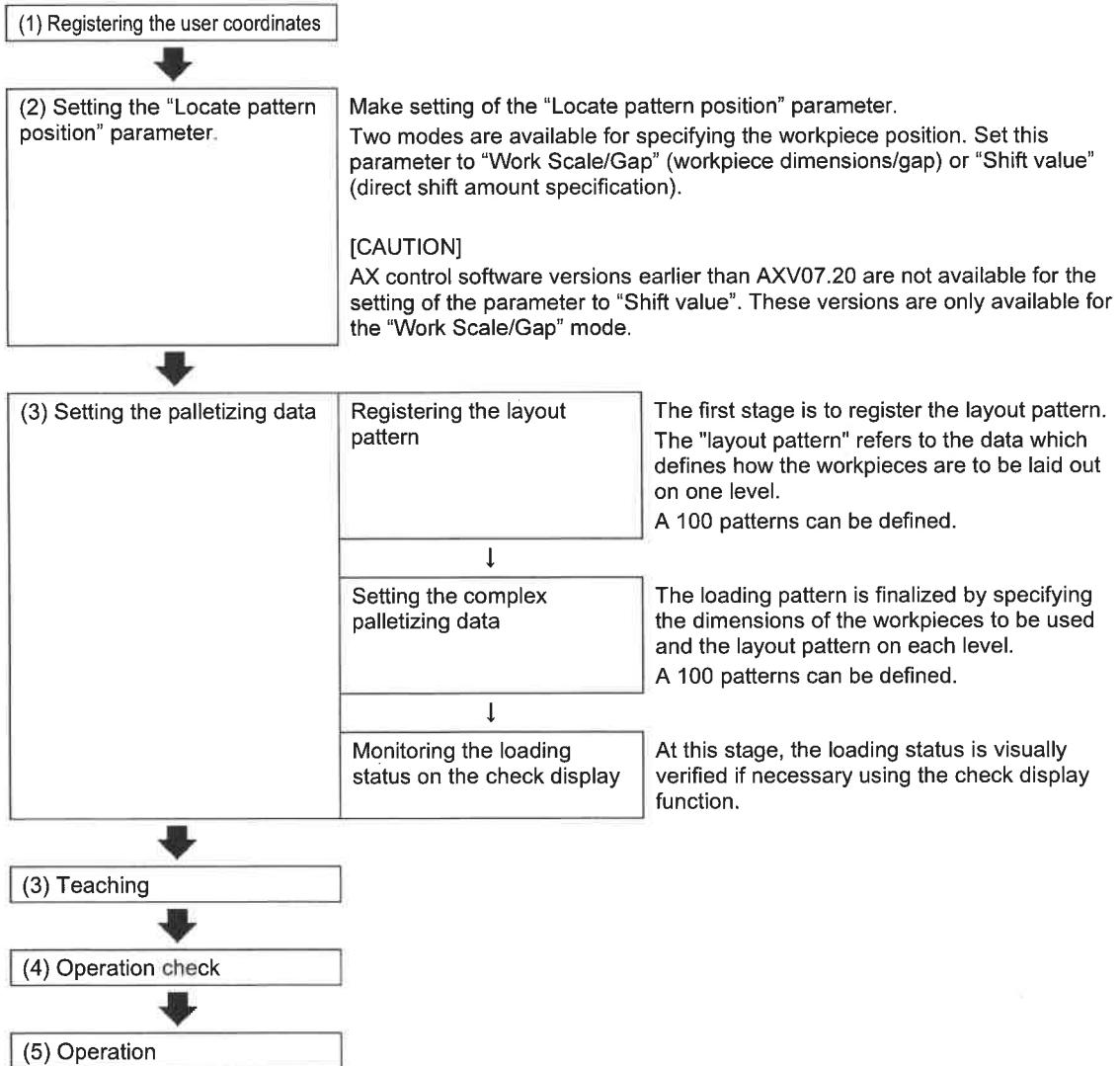


Fig. 4.1.2 Setting procedure for complex palletizing

The following sections describe each of these operations in sequence.

4.2 Registering the user coordinates

Since, whether simple palletizing or complex palletizing is used, the palletizing operations involve shift operations based on user coordinate systems, the user coordinate system to serve as the reference must be registered in advance.

The actual operating procedure is skipped since it is the same as for simple palletizing.

4.3 Setting of “Locate pattern position” parameter

This parameter is used to make setting of a mode for specifying workpiece position (location) in a plane for highly effective palletizing.

Two modes are available for specifying the workpiece position. Set the “Locate pattern position” parameter to “Work Scale/Gap” mode by which workpiece dimensions and gap are specified or “Shift value” mode by which the shift amount of each workpiece is directly specified.



IMPORTANT

AX control software versions earlier than AXV07.20 are not available for the setting of the parameter to “Shift value”. These versions are only available for the “Work Scale/Gap” mode.

- 1 Set the Operation Mode selector switch to “TEACH”.



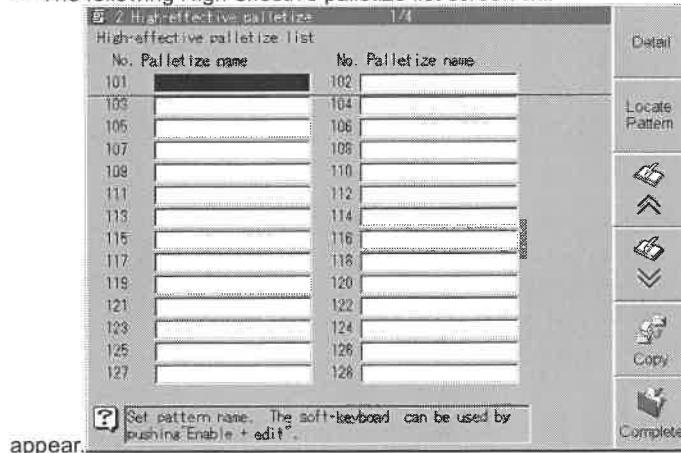
- 2 Select “17 Handling Application” from the constant menu.

>> The following setting screen dedicated to handling will appear.



- 3 Select “2 High-effective palletize” from the menu.

>> The following High-effective palletize list screen will





- 4 Press the f8 key [Locate Pattern].
It does not matter wherever the cursor is placed.
>> The following Locate pattern list screen will appear.

⑤ 2 High-effective palletize

1/3

Locate pattern list			Detail
No.	Pattern name	No. Pattern name	No. Pattern name
1	[Redacted]	2	
4		5	6
7		8	9
10		11	12
13		14	15
16		17	18
19		20	21
22		23	24
25		28	27
26		29	30
31		32	33
34		35	36
37		38	39
40		41	42

Condition Setting

Copy

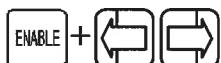
Complete

Set locate pattern name. The soft-keyboard can be used by pushing "Enable + edit".



- 5 Press the f8 key [Condition Setting].
It does not matter wherever the cursor is placed.**
>> The following Locate pattern position screen will appear.

- * Making a change to the setting of the “Locate pattern position” parameter will clear the layout patterns XA, XD, XS1, XS2, YA, YD, YS1, YS2, and (X, Y, Z, θ z).



- 5 Put the cursor on “Locate pattern position” in the following manner.**
Press the [ENABLE] key and [\leftarrow] or [\rightarrow] key at one time to select the radio button (the selector button in the row of the parameter). Subsequently, put the cursor on “Locate pattern position”, and then press the f12 key [Complete].

4.4 Registering the layout pattern

The location pattern registration screen varies with the setting of the "Locate pattern position" parameter.

The following section describes the location pattern registration procedure in "Work Scale/Gap" mode and the "Shift value" mode, respectively.

4.4.1 Procedure for defining workpiece position (in "Work Scale/Gap" mode)

First, how the workpiece positions (locations) are defined within a plane with complex palletizing will be described. This part forms the basis of the method used to define the layout pattern.

With complex palletizing, the locations of each workpiece to be laid out on one level are specified using the "ratio" to the workpiece dimensions. They are not specified in terms of absolute positions. Any workpiece dimensions can be set by using the method described later. Even if the workpieces have different dimensions, the same "layout pattern" can be used if the workpieces are to be loaded in the same way.

The locations of the workpieces (their positions on the XY plane) are obtained using the following formula.

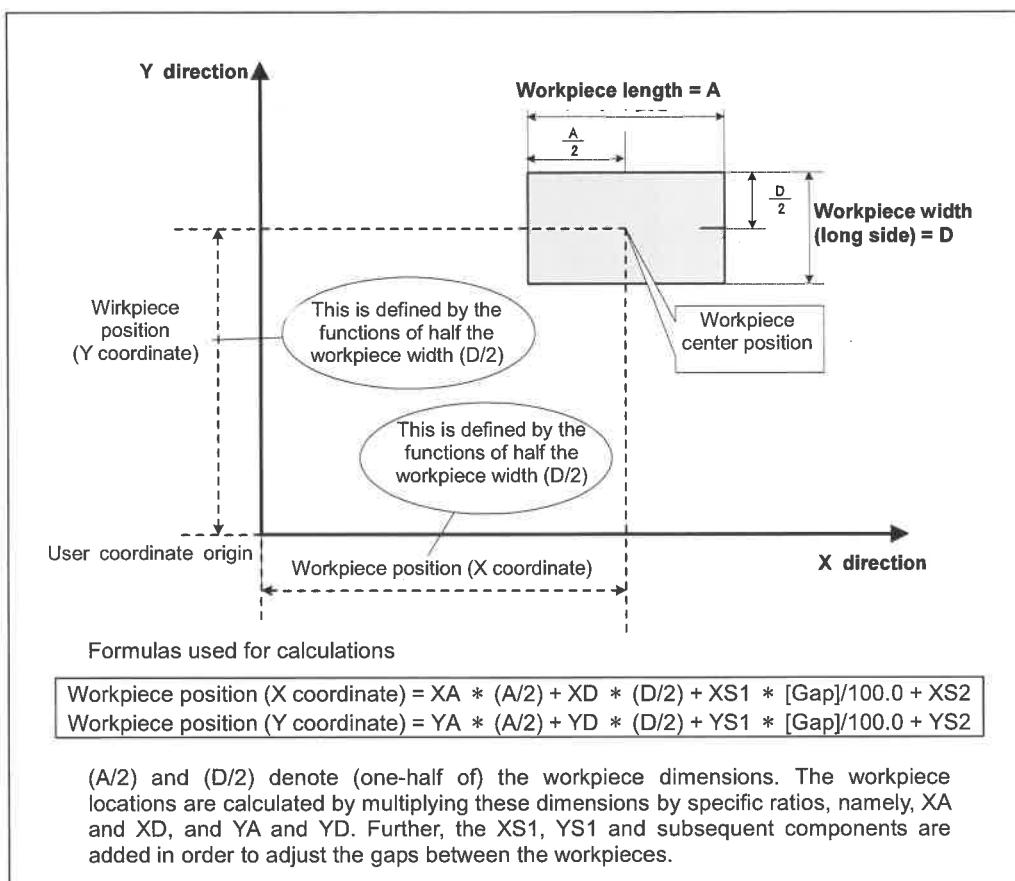


Fig. 4.4.1 Formula for calculating the locations of the workpieces (their positions on the XY plane)

The method used to calculate specific dimensions is explained below with the aid of diagrams. To make it easier to understand, the method is described for each of three patterns in which gaps are provided between the workpieces:

- [Example 1: Method for patterns with fixed gaps]
- [Example 2: Method for patterns with variable gaps]
- [Example 3: Method for patterns with both fixed and variable gaps]

[Example 1: Method for patterns with fixed gaps]

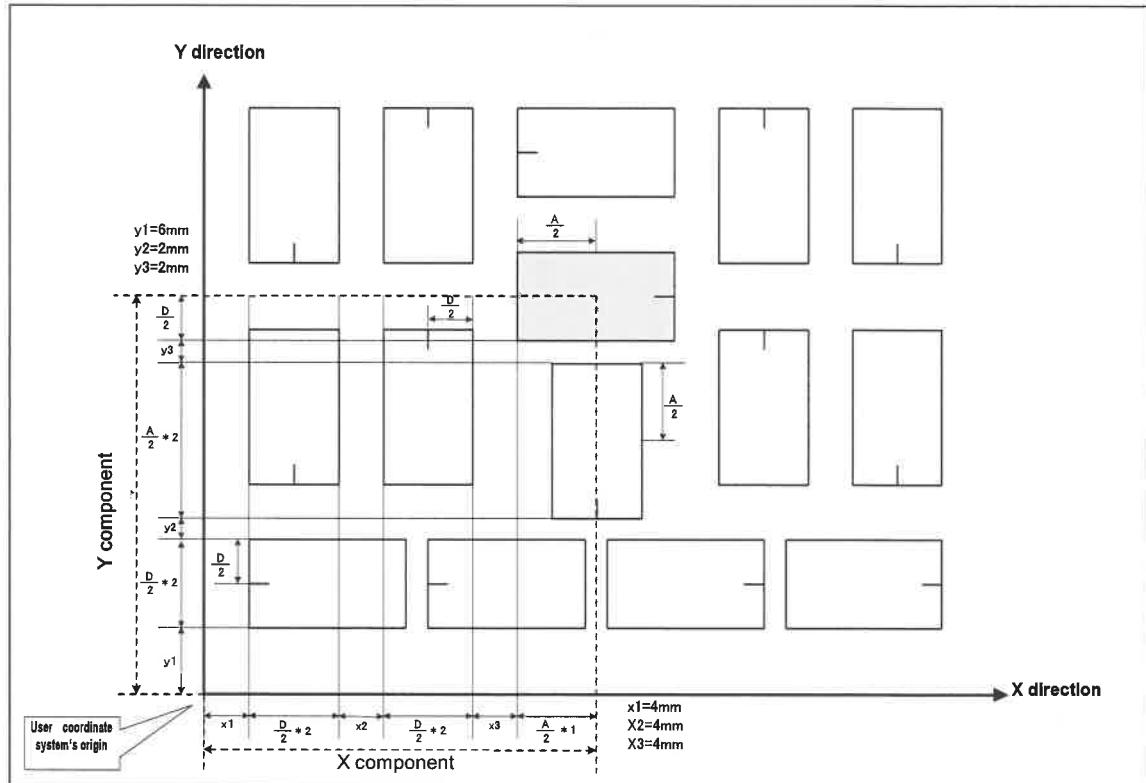


Fig. 4.4.2 Definition of workpiece locations when fixed gaps are provided between the workpieces

- <X component> In the figure, the locations of the shaded workpiece (X coordinate) are as follows:
The X component is obtained by adding one ($A/2$) dimension, four ($D/2$) dimensions, and the lengths of x_1 , x_2 and x_3 as the gaps between the workpieces.
Therefore, X_A is 1, X_D is 4 and X_{S2} is 12 mm (4 mm + 4 mm + 4 mm).
When this is applied to the calculation formula:

$$\text{X component} = 1 * (A/2) + 4 * (D/2) + 12$$

- <Y component> In the figure, the locations of the shaded workpiece (Y coordinate) are as follows:
The Y component is obtained by adding two ($A/2$) dimensions, three ($D/2$) dimensions, and the lengths of y_1 , y_2 and y_3 as the gaps between the workpieces.
Therefore, Y_A is 2, Y_D is 3 and Y_{S2} is 10 mm (6 mm + 2 mm + 2 mm).
When this is applied to the calculation formula:

$$\text{Y component} = 2 * (A/2) + 3 * (D/2) + 10$$

[Example 2: Method for patterns with variable gaps]

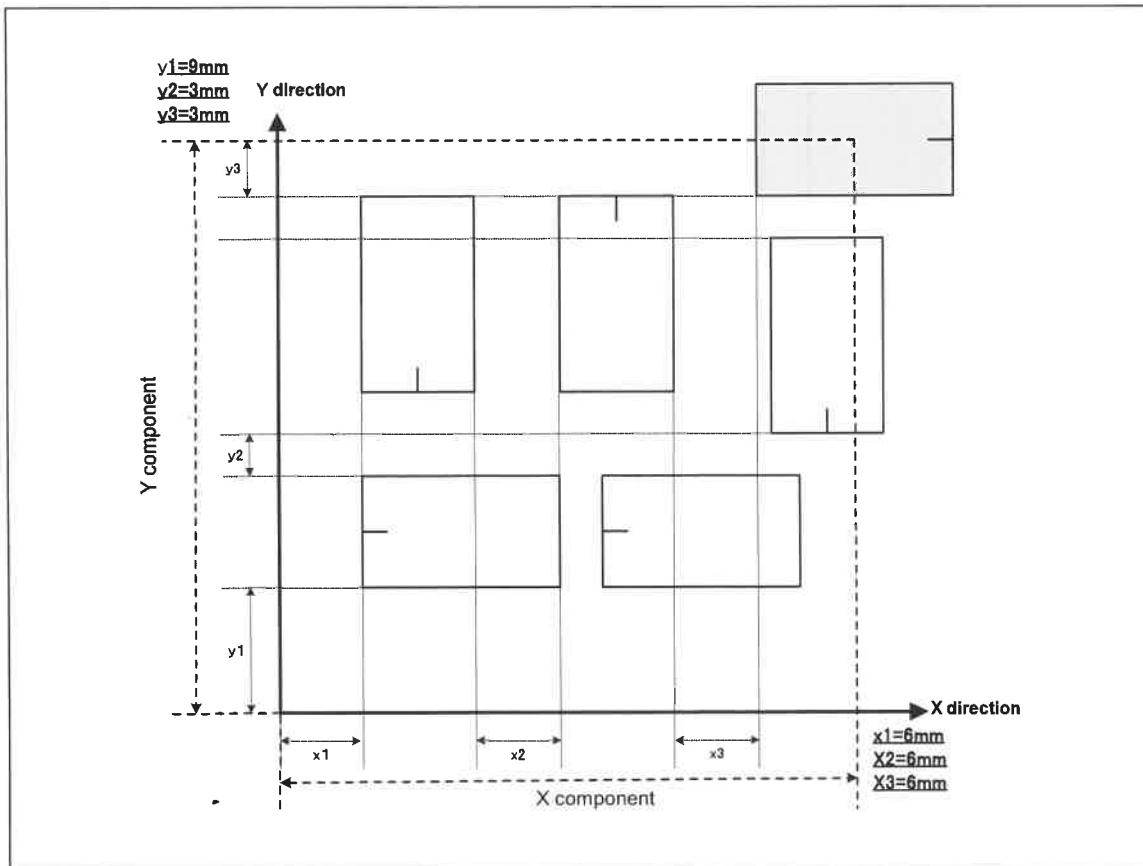


Fig. 4.4.3 Defining the workpiece locations when variable gaps are provided between the workpieces

If, as shown in the diagram, the original $XS1$ (12 mm) and $YS1$ (12 mm) values are to remain unchanged and the gap distance is to be increased by 1.5 fold overall, 150% is set for the gap factor.

When this is applied to the calculation formula, the following is obtained.

$$\begin{aligned} \text{X component} &= 1 * (A/2) + 4 * (D/2) + 12 * 150\% / 100 \\ \text{Y component} &= 2 * (A/2) + 3 * (D/2) + 10 * 150\% / 100 \end{aligned}$$

[Example 3: Method for patterns with both fixed and variable gaps]

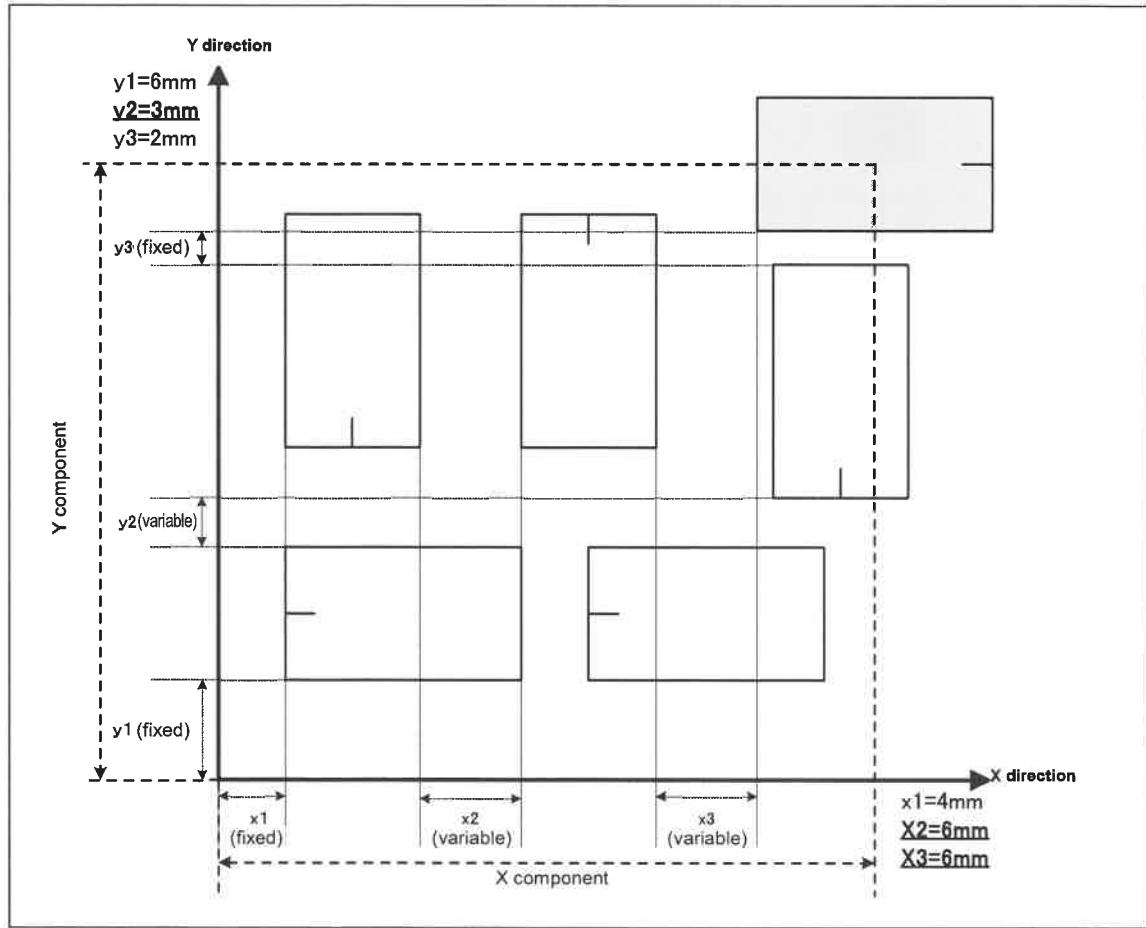


Fig. 4.4.4 Defining the workpiece locations when both fixed and variable gaps are provided between the workpieces

If, as shown in the diagram, only x_2 , x_3 and y_2 are to be varied (1.5 fold) and the other gaps are to be made fixed — that is, not subject to the gap factor, the parts with the variable gaps are set in $XS1$ ($x_2 + x_3$) and $YS1$ (y_2), and the parts with the fixed gaps are set in $XS2$ (x_1) and $YS2$ ($y_1 + y_3$).

When this is applied to the calculation formula, the following is obtained.

$$\begin{aligned} X \text{ component} &= 1 * (A/2) + 4 * (D/2) + 8 * 150\% / 100 + 4 \\ Y \text{ component} &= 2 * (A/2) + 3 * (D/2) + 2 * 150\% / 100 + 8 \end{aligned}$$

4.4.2 Registering location pattern (in “Work Scale/Gap” mode)

1 Select the [TEACH] mode

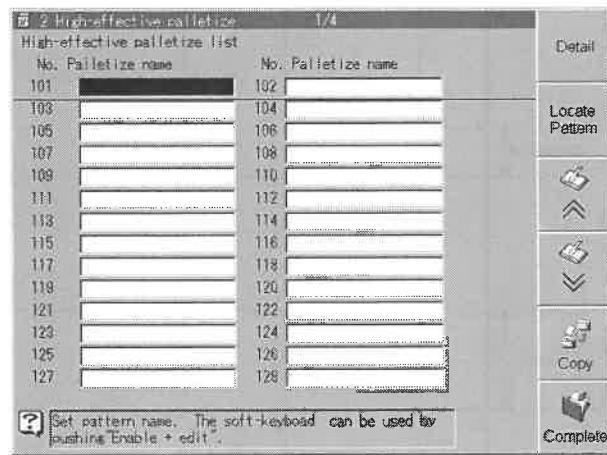


2 Open [Constant Setting][17 Handling Application][2 High-effective palletize] screen.

>>The following screen will appear.



3 Select “2 High-effective palletize” from the menu.

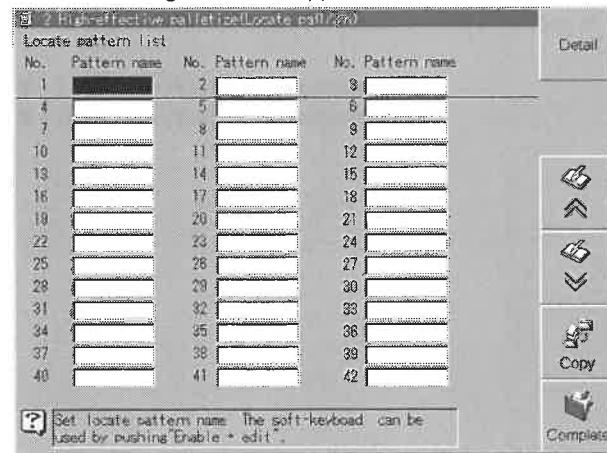


Up to 100 complex palletizing patterns can be registered. The numbers in the vertical columns are the numbers of these operations. With teaching, the pattern numbers (101 to 200) are specified using the application commands.

When each detailed display screen is opened, a screen on which the pattern names, dimensions and other detailed information is set appears.

4 First, press f key <Locate Pattern> to define the layout pattern. It does not matter where the cursor is positioned.

>> The following screen will appear.

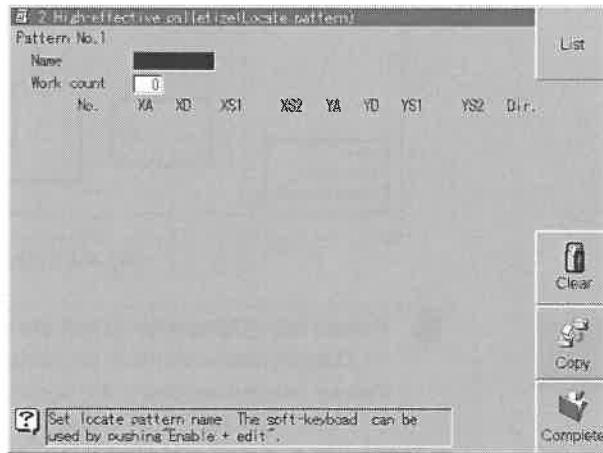


The layout patterns for up to 100 complex palletizing patterns can be registered. The numbers in the vertical columns are the numbers of these operations.



- 5 Align the cursor to the name field for the number of the layout pattern to be set, and press f key <Detail>. It does not matter if the numbers are not continuous.**

>> The following screen will appear.



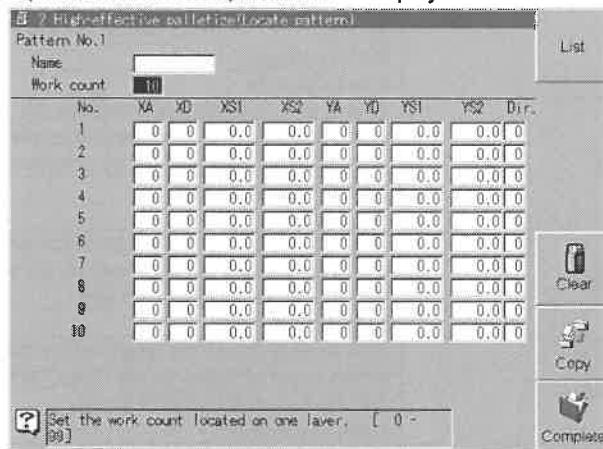
In the default status, the number of workpieces is set to zero as in the figure above, and no input fields for setting the data are displayed.

- 6 Align the cursor with the "Name", and register a unique name which is easy to identify.**

Open the soft keyboard by pressing [ENABLE] and [EDIT] keys, and input the name.

- 7 Align the cursor with the "Work count", and input the number of workpieces to be laid out on one level of this layout pattern.**

>> If, for instance, 10 have been input as the work count, the input fields equivalent to ten workpieces will be displayed as shown below.



If a figure above 12 is specified for the work count, press [Down] key while holding down [ENABLE] key to display the data input field for the thirteenth and subsequent workpieces.

- 8 Specify the locations of each workpiece using the four parameters.**

X direction; XA, XD, XS1, XS2

Y direction; YA, YD, YS1, YS2

Since the layout pattern is for one level only — that is, it represents 2-dimensional data, there is no need to specify the height of the workpieces.

For details, refer to 4.4.1 Method used to define the workpiece position.

- 9** Next, specify the "Dir." (direction) data for specifying the rotation direction of each workpiece. Select one of the five patterns (numbers 0 to 4) depending on the angle of rotation as referenced to the user coordinate system.

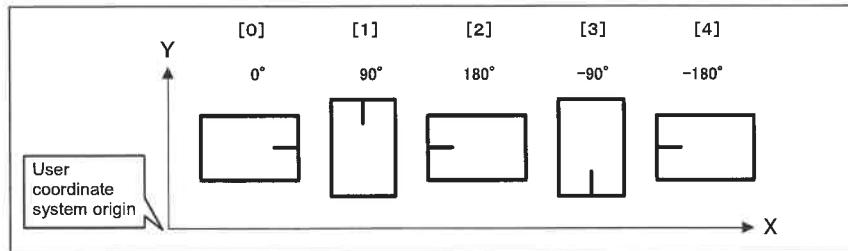


Fig. 4.4.5 Work directions ("Dir.")



- 10** Press f key <Complete> to exit the setting screen.

>> Operation now returns to the complex palletizing list screen in step 3.
The set data is recorded in the layout pattern data file (PALLET-LOC.CON).

Table 4.4.1 List of layout pattern parameters

Item	Description
Name	This is used to set a unique name for identifying the layout pattern. Setting range: 10 half-size characters (full-size characters may also be used) Initial value: Full-size/half-size space characters
Work count	This is used to specify the number of workpieces to be laid out on one level. The subsequent data must be specified for the number of workpieces which has been set in this parameter. Setting range: 0 to 99 Initial value: 0
XA (YA)	This is a parameter that indicates the X (Y) component of the workpiece position, and it specifies the multiple of the reference length obtained by halving "workpiece dimension A" which is set by complex palletizing. Setting range: 0 to 99 Initial value: 0
XD (YD)	This is a parameter that indicates the X (Y) component of the workpiece position, and it specifies the multiple of the reference length obtained by halving "workpiece dimension D" which is set by complex palletizing. Setting range: 0 to 99 Initial value: 0
XS1 (YS1)	This is used to set the length of the gap between workpieces in the X (Y) direction which is affected by the "Gap" factor set by complex palletizing. Setting range: 0.0 to 999.9 mm Initial value: 0.0
XS2 (YS2)	This is used to set the length of the gap between workpieces in the X (Y) direction which is not affected by the "Gap" factor set by complex palletizing. Setting range: 0.0 to 999.9 mm Initial value: 0.0
Dir.	This is used to specify the direction (rotation) of the workpieces from the five patterns. Setting range: 0 to 4 Initial value: 0



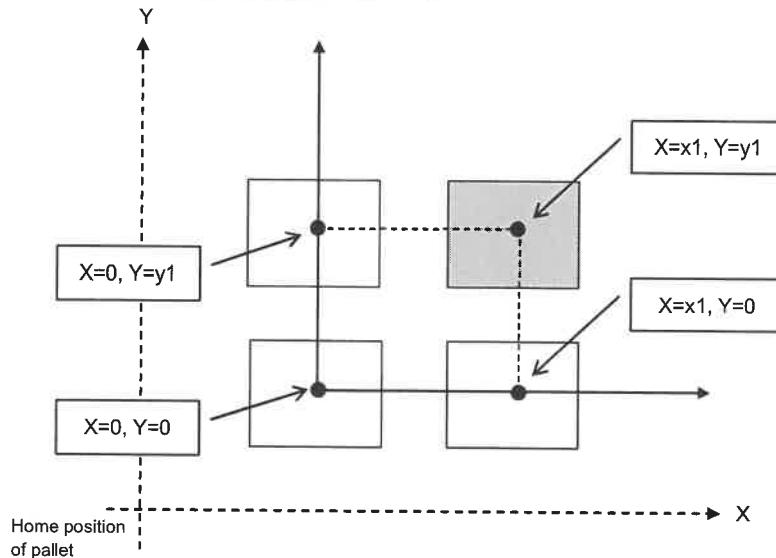
- 11** To clear location pattern data, press the f10 key [Clear].

4.4.3 Procedure for defining workpiece position (in “Shift value” mode)

The “Shift value” mode is used to specify the location of each workpiece to be arranged in a layer (i.e., tier) using the shift amount X, Y, and Z of each workpiece and workpiece rotating rate θ_z .

The shift amounts of the workpiece in the X and Y directions are found by the following two methods depending on which point is taken as the home position for shift.

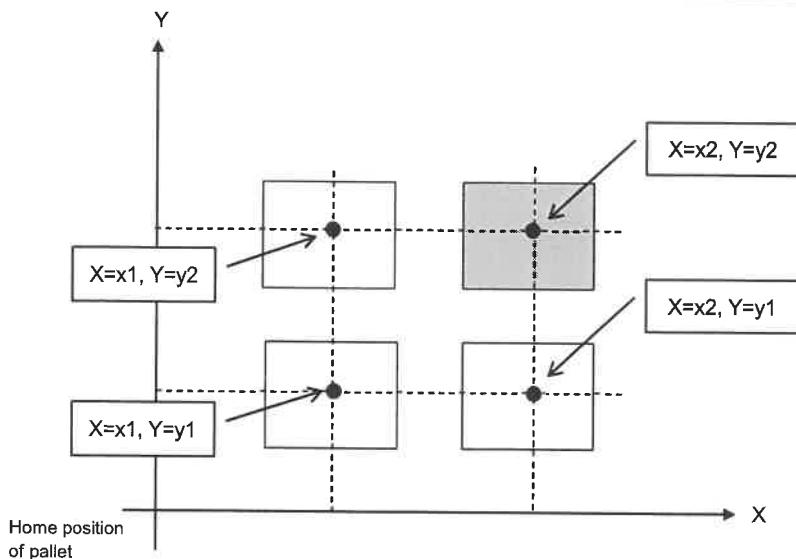
1. To take any workpiece as the home position:



The figure above shows an example with workpiece located at the lower left taken as the home position.
The shift amount of the hatched workpiece in the X and Y directions comes to $X=x_1$ and $Y=y_1$, respectively.

To make this setting, the home position offset (“Origin offset” parameter) for palletize detail setting must be set to “0”.

2. To take the home position of pallet (that of user coordinate) as the home position:

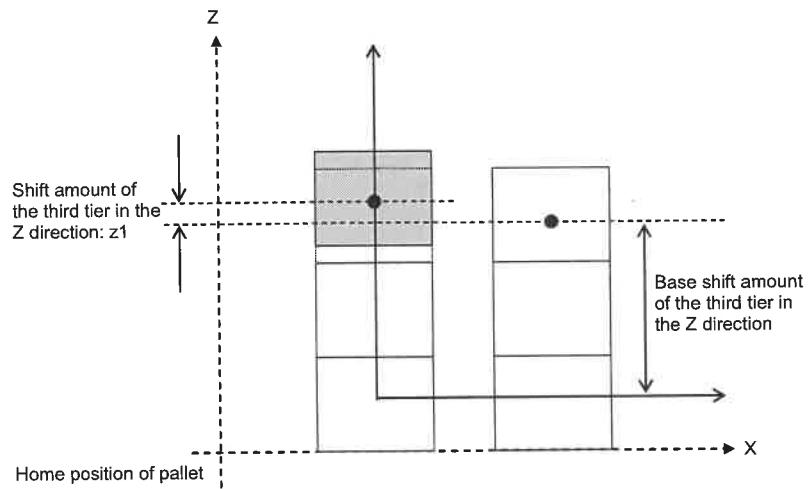


The figure above shows an example with the home position of pallet taken as the home position.
The shift amount of the hatched workpiece in the X and Y directions comes to $X=x_2$ and $Y=y_2$, respectively.

To make this setting, setting of the home position offset for palletize detail setting must be made.

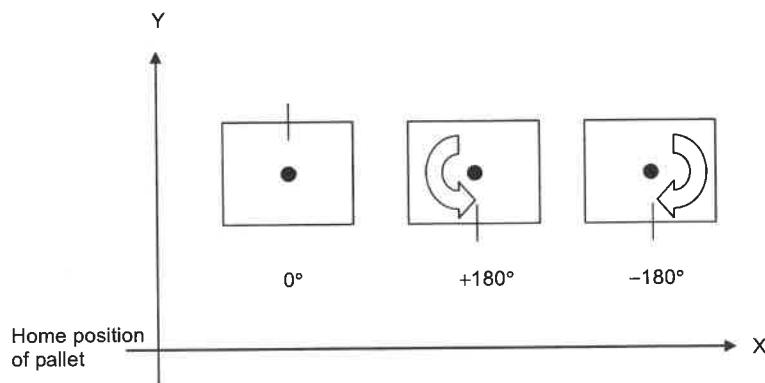
The shift amount of the workpiece in the Z direction comes to an offset from the base shift amount of each layer in the Z direction.

For the base shift amount of each layer in the Z direction, refer to information in "4.5.2 Setting of highly effective palletizing data (in "Shift value" mode)".



In case of an example shown in the figure above, the shift amount of hatched workpiece in the Z direction comes to $Z=z1$.

The setting of workpiece rotation rate θ_z is made by an angle at which the workpiece rotates around its center in the angle range of -180° to $+180^\circ$.



4.4.4 Registering location pattern (in “Shift value” mode)



- 1 Set the Operation Mode selector switch to “TEACH”.
 2 Select “17 Handling Application” from the constant menu.

>> The following setting screen dedicated to handling will appear.



- 3 Select “2 High-effective palletize” from the menu.
 >> The following High-effective palletize list screen will appear.

④ 2 High-effective palletize 1/4		Detail	
No.	Palletize name	No. Palletize name	Detail
101		102	
103		104	
105		106	
107		108	
108		110	
111		112	
113		114	
115		116	
117		118	
119		120	
121		122	
123		124	
125		126	
127		128	

Set pattern name. The soft-keyboard can be used by pushing “Enable + edit”.

A maximum of highly effective palletizing location patterns can be registered. The numbers arranged longitudinally represent these patterns. Teaching is conducted so as to specify these numbers (palletizing numbers 101 to 200) by application commands.

Opening the detail display screen by each number will display the corresponding screen for setting detail data such as pattern names and dimensions.



- 4 To define location patterns, press the f8 key [Locate Pattern].
 It does not matter wherever the cursor is placed.

>> The following Locate pattern list screen will appear.

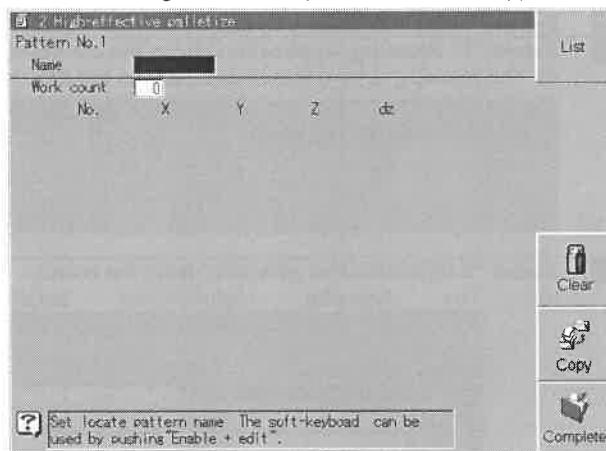
④ 2 High-effective palletize 1/3			Detail	
No.	Pattern name	No. Pattern name	No. Pattern name	Detail
1		2	3	
4		5	6	
7		8	9	
10		11	12	
13		14	15	
16		17	18	
19		20	21	
22		23	24	
25		26	27	
28		29	30	
31		32	33	
34		35	36	
37		38	39	
40		41	42	

Set locate pattern name. The soft-keyboard can be used by pushing “Enable + edit”.

A maximum of 100 highly effective palletizing location patterns can be registered. The numbers arranged longitudinally represent these patterns.

Detail

- 5** Put the cursor on the name box of a location pattern number, the setting of which you want to make, and then press the f7 key [Detail]. It does not matter even though the pattern numbers are discrete.
 >> The following detail locate pattern screen will appear.



←Press this key to display the Locate pattern list screen.



←Press this key to initialize all data displayed.
 ←Press this key to copy data displayed to a different pattern number.

In the default status, the number of workpieces is set to "0" as shown in the figure above, and no boxes in which setting data are input are displayed.

- 6** Put the cursor on the name box, and then register an easy-to-understand unique name.
 Open the soft keyboard pressing the [ENABLE] and [EDIT] keys at one time, and then enter such name in the name box.
- 7** Put the cursor on the Work count box, and then enter the number of workpieces for one layer of this location pattern.
 >> For example, if "10" is entered in the Work count box, enter boxes for 10 workpieces will be displayed as shown

No.	X	Y	Z	dz
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0



If "12" or more is input in the Work count box, pressing the $\langle \rangle$ key while pressing the $\langle \text{ENABLE} \rangle$ key will display the data input box for the 13th location pattern or later.

- 8** Specify the location of workpiece one after another using the following parameters.
 X direction; X
 Y direction; Y
 Z direction; Z
 Workpiece rotation rate: θz

For detail, refer to information in "4.4.3 Procedure for defining workpiece position (in "Shift value" mode)".



- 9** Press the f12 key [Complete] to exit the setting screen.
 >> The display will return to the Locate pattern list screen in Step 4. Set data will be recorded in the location pattern data file (PALLET-LOC.CON).

Table 4.4.2 List of location pattern parameters

Parameter	Description of function (setting range and default value)
Name	Used to make setting of unique name in order to identify location pattern. Setting rage: 10 one-byte characters (Double-byte characters are also available) Default value: One- and double-byte space character
Work count	Used to specify the number of workpieces to be arranged in one layer. Subsequent data for the number of workpieces specified by this parameter must be specified. Setting range: 0 to 99 Default value: 0
X	Used to make setting of the shift amount of workpiece position in the X direction. Setting range: -9999.9 to +9999.9 mm Default value: 0.0 mm
Y	Used to make setting of the shift amount of workpiece position in the Y direction. Setting range: -9999.9 to +9999.9 mm Default value: 0.0 mm
Z	Used to make setting of the offset amount of workpiece position in the Z direction. Setting range: -9999.9 to +9999.9 mm Default value: 0.0 mm
θz	Used to make setting of workpiece rotation angle. Setting range: -180.0° to +180.0° Default value: 0.0°



11 To clear location pattern data, press the f10 key [Clear].

>> The message "Is it OK to clear the data?" will be displayed. Select "Yes".

4.5 Setting the complex palletizing data

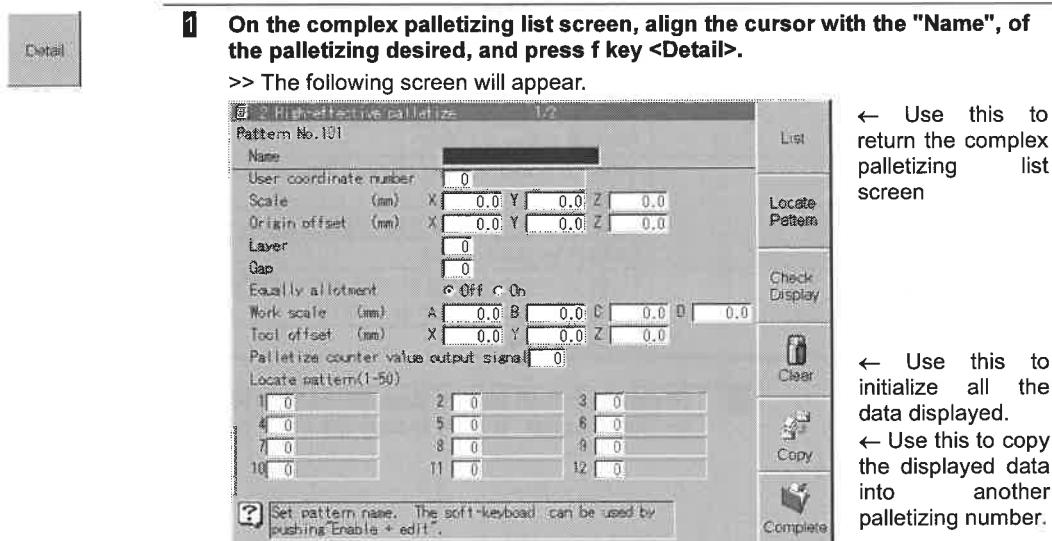
The final load data is set after the layout pattern to be used has been set.

Complex palletizing enables a total of 100 patterns to be set. The palletizing numbers extend from 101 to 200. (Palletizing numbers 1 to 100 are for simple palletizing.)

The location pattern registration screen varies with the setting of the "Locate pattern position" parameter.

The following section describes the location pattern registration procedure in "Work Scale/Gap" mode and the "Shift value" mode, respectively.

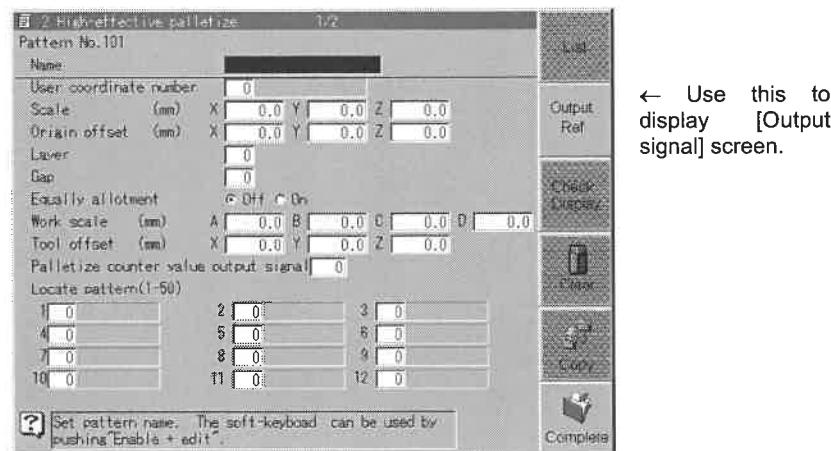
4.5.1 Setting of highly effective palletizing data (in "Work Scale/Gap" mode)



On this screen, the final load data is set by specifying the layout pattern for each level and also the dimensions of the workpieces which will be used.

Press [ENABLE] key.

>> The arrangement of f key changes as follows.



- 2 Align the cursor with the name field, and register a unique name which is easy to identify.**
 Open the soft keyboard by pressing [ENABLE] and [EDIT] keys, and input the name.
- 3 Align the cursor with the "User axis number," and input the number of the pre-defined user coordinates.**
 >> When the user coordinate number is set, the comment which is set for the corresponding user coordinate data is displayed. (Comments cannot be edited on this screen. A comment which has not been set will not be displayed.)
- 4 Align the cursor with "Scale," and specify the dimensions of the pallet to be used.**
 >> The X and Y components are used for "Check display" and "Equally allotment." The check display will fail to appear if values above 0 are not set for the X and Y components. The Z component is used for "Z-direction shift amount."

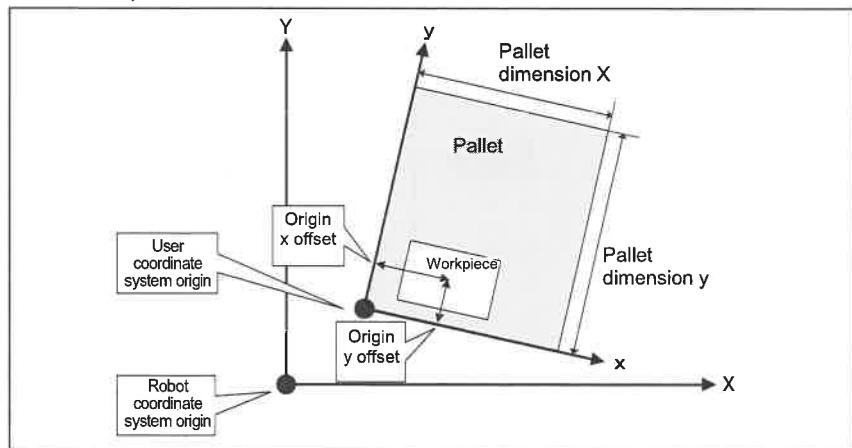


Fig. 4.5.1 Pallet dimensions ("Scale") and origin point offset

- 5 Align the cursor with "Origin offset," and specify how far away the loading (unloading) point of the first workpiece is to be distanced from the user coordinate origin. (Refer to Fig. 4.5.1.)**
- 6 Align the cursor with "Layer," and specify the number of workpiece loading levels.**
 >> A number up to 50 levels can be specified. The layout pattern must be specified for all the levels defined here.
- 7 Align the cursor with "Gap," and set the gap factor.**
 >> The gap factor acts on the XS1 data and YS1 data which have been set in "Locate pattern." By using it, the gap distance between workpieces can easily be changed. (Refer to Fig. 4.4.3.)
- 8 Align the cursor with "Equally allotment," and specify whether or not to automatically offset the positions of all the workpieces so that the center of all the workpieces laid out on one level is at the center of the pallet.**
- 9 Align the cursor with "Work scale," and input the four data items for the length, height, width (short side) and width (long side).**

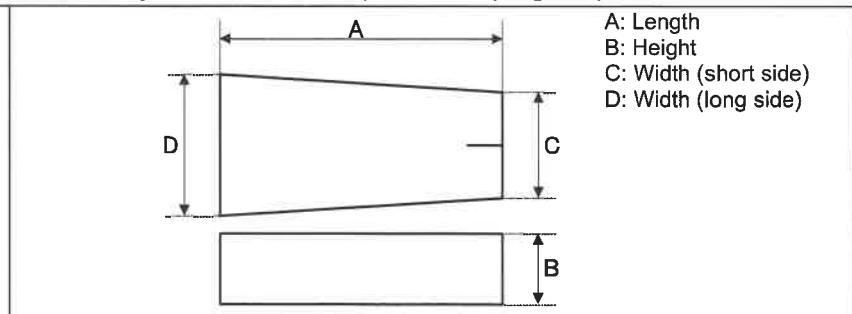


Fig. 4.5.2 Work dimensions ("Work scale")

Even if the workpiece has the same dimension for its short and long side widths, this does not cause a problem.

- 10 Align the cursor with "Tool offset," and specify the position of the tool relative to the position of the workpiece on the gripper.**

Tool offset denotes the gap between the moving side jaw and the workpieces. In the case of the example shown in the figure, the tool offset values are 200 mm for X and 0 mm for Y and Z.

There is no need to enter the offset values if the tool tip center (TCP) is always aligned with the workpiece center.

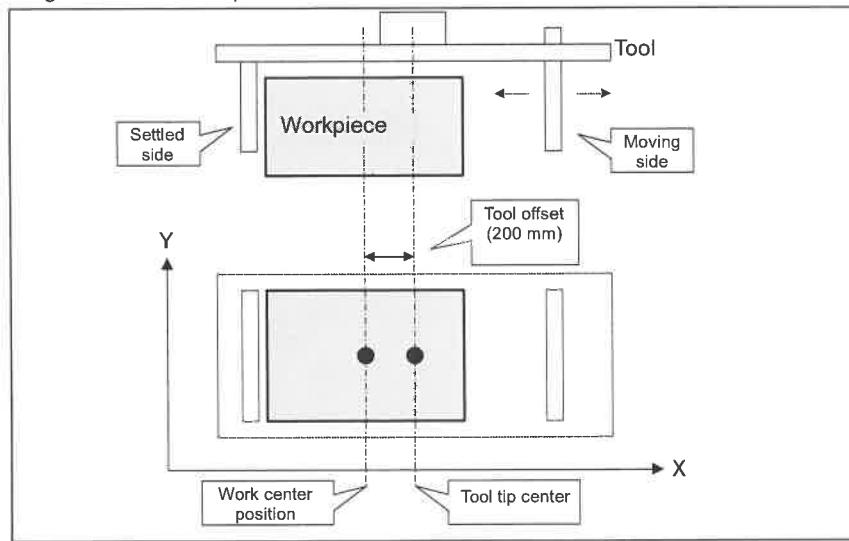


Fig. 4.5.3 Tool offset

- 11 Align the cursor with "Locate pattern," and set the layout pattern numbers for all the loading levels. The figures on the left of the table denote the numbers of the levels. No.1 denotes the bottom level, and each successively higher number in turn denotes a successively higher level above it.**

>> When the layout pattern is set, the "Locate pattern name" for the corresponding pattern number appears next to the number field.



If the number of levels exceeds 15, press [Down] key while holding down [ENABLE] to display the layout pattern input fields.



- 12 Press f key <Complete> to exit the setting screen.**

>> Whether any data is still to be set is checked, and if there are no problems, the data set is saved in the complex palletizing data file (PALLET-CPX.CON).

If data still to be set is detected, a message such as the one shown below appears. Set the appropriate value, and perform the data save operation again.

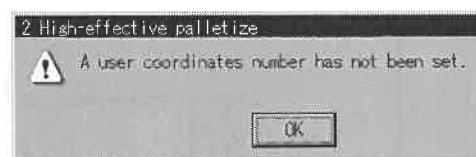


Table 4.5.1 List of complex palletizing parameters

Item	Description
Name	This is used to set a unique name for identifying complex palletizing. Setting range: 20 half-size characters (full-size characters may also be used) Initial value: Full-size/half-size space characters
User axis number	This is used to set the number of the user coordinate system used by the palletizing task. It must be registered on [Service Utilities][10 User Coord. Definition] screen in advance. Setting range: 1 to 100 Initial value: 0
Scale	This is used to specify the dimensions of the pallet used. This data is used for "Check display," "Equal allotment" or "Z-direction shift amount." The check display will fail to appear if values above 0 are not set for X and Y. Setting range: 0 to 6,000 mm Initial value: 0
Origin offset	This is used to specify how far away the loading (unloading) point of the first workpiece is to be distanced from the user coordinate origin. Setting range: -3,000.0 to 3,000.0 mm Initial value: 0.0 mm
Layer	This is used to specify the number of levels to which the workpieces are to be loaded. (*) When setting a depalletize operation, please set minus value for this parameter. Setting range: -50 to 50 Initial value: 0
Gap	This is used to specify the gap factor. The gap factor acts on the XS1 data and YS1 data which have been set in "Locate pattern." By using it, the gap distance between workpieces can easily be changed. Refer to Fig. 4.3.3 Defining the workpiece locations when variable gaps are provided between the workpieces. Setting range: 0 to 999% Initial value: 0
Equally allotment	This is used to automatically offset the positions of all the workpieces so that the center of all the workpieces laid out on one level is at the center of the pallet. Setting range: <Off/On> Initial value: <Off>
Work dimensions ("Work scale")	This is used to set the workpiece dimensions (A: length, B: height, C: width (short side), D: width (long side)). Refer to Fig. 4.4.2 Work dimensions ("Work scale"). Setting range: 0.0 to 999.9 mm Initial value: 0.0 mm
Tool offset	This is used to set the offset amount between the tool tip and position where the workpiece is held. Refer to Fig. 4.4.3 Tool offset. Setting range: -999.9 to 999.9 mm Initial value: 0.0 mm
Layout pattern ("Locate pattern")	This is used to set the number of the layout pattern to be used. This parameter must be set for each of the levels set. Setting range: 0 to 100 Initial value: 0



13 Press f key <Clear> to clear the palletize data.

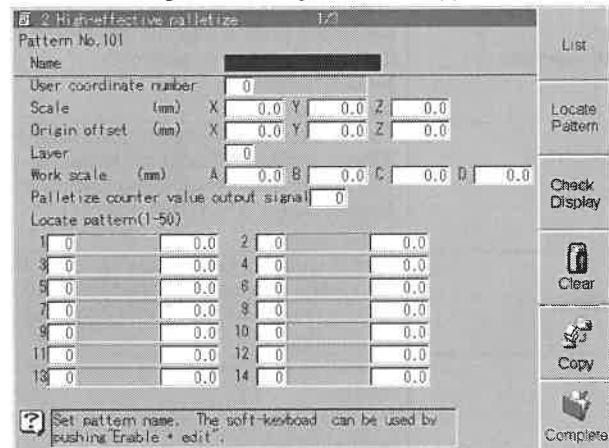
>>A message "Do you clear palletize data?" is displayed. Select [Yes] and press [Enter].

4.5.2 Setting of highly effective palletizing data (in “Shift value” mode)

Detail

On the High-effective palletize screen, put the cursor on the Name box, and then press the f7 key [Detail].

>> The following detail setting screen will appear.



←Press this key to return the display to the High-effective palletize list screen.

←Press this key to initialize all data displayed.

←Press this key to copy data displayed to a different pattern number.

By specifying location patterns by layers and further specifying the dimensions of workpieces to use on this screen, settings of final loading data are made.

Press [ENABLE] key.

>> The arrangement of f keys will be changed as shown below.



← Press this key to display the Output signal screen.

Put the cursor on the name box, and then register an easy-to-understand unique name.

Open the soft keyboard pressing the [ENABLE] and [EDIT] keys at one time, and then enter such name in the name box.

Put the cursor on the User coordinate number box, and then enter the pre-defined user coordinate number in the box.

>> Upon completion of setting of the user coordinate number, a comment preset to the relevant user coordinate data will be displayed. (On this screen, no comments can be edited. Furthermore, no comments are displayed unless preset.)

Put the cursor on the Scale box, and then specify the dimensions of a pallet to use.

>> The X and Y components are used to execute the “Check display” function. Unless “0” or more value is set to the X and Y components respectively, the “Check display” function cannot be executed.

The Z component is used to make setting of shift amount in the Z direction.

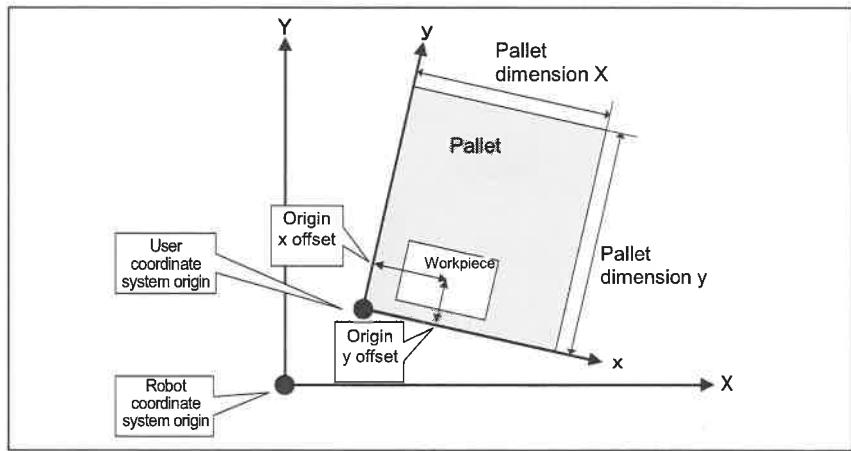


Fig. 4.5.4 Pallet dimensions and offsets of home positions

If any workpiece is set to the home position, set all offsets of home positions to "0".

If the home position of pallet is set to the home position, put the cursor on the Origin offset box, and then specify a distance between the loading (unloading) point of the first workpiece and the home position of the user coordinate.

For the specification, refer to Fig. 4.5.4 Pallet dimensions and offsets of home positions.

Put the cursor on the Layer box, and then specify the number of layers to load.

>> A maximum of 50 layers can be specified. For all layers defined by this parameter, location patterns must be specified.

Put the cursor on the Work scale box, and then enter length, height, width (short side), and width (long side) of workpiece.

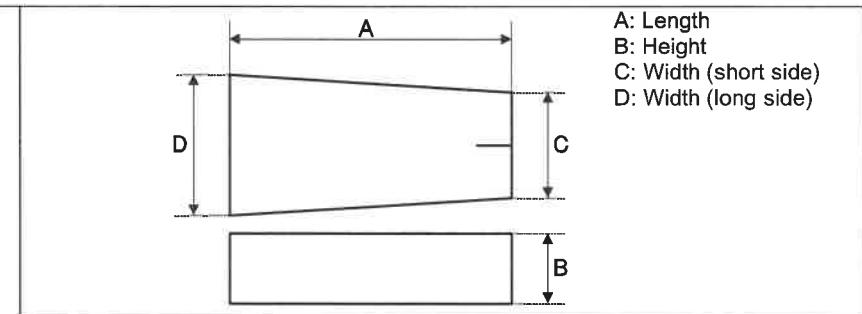


Fig. 4.5.5 Workpiece dimensions

Even workpieces having short and long sides in the same length present no particular problems.

In "Shift value" mode, workpiece dimensions are only used on the Check display screen.

Put the cursor on the Locate pattern box, and then make setting of locate pattern numbers for all layers. Numbers shown on the left-hand side of the table represent the numbers of layers. The number "1" represents the bottom layer, and as the number becomes larger, the layer becomes higher.

>> Every time a pattern number is set, a "location pattern name" corresponding to this number will be displayed next to the number box.

Put the cursor on the base shift amount in the Z direction, and then make setting of base shift amounts in the Z-direction for all layers.

In case of the number of layers exceeding "15", pressing the <|> key while pressing the <ENABLE> key will display the location pattern input box.





Press the f12 key [Complete] to exit the setting screen.

>> Whether there are any data which is not set checked. If all data settings are properly made, the set data will be saved in the highly effective palletize data file (PALLET-CPX.CON).

If any data to be set are detected, the following message will be displayed. In this case, make setting of a proper value, and then press the f12 key [Complete] again.

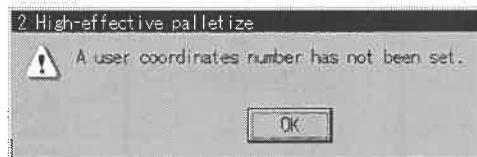


Table 4.5.2 List of highly effective palletizing parameters

Parameter	Description of function (setting range and default value)
Name	Used to make setting of unique name in order to identify highly effective palletizing. Setting rage: 20 one-byte characters (Double-byte characters are also available) Default value: One- and double-byte space character
User coordinate number	Used to make setting of user coordinate system number used for palletizing. The user coordinate number must be registered in advance on the "10 User Coord Definition" screen in the "Service Utilities" menu. Setting range: 1 to 100 Default value: 0
Pallet dimensions	Used to specify the dimensions of pallet to use. The pallet dimensions data are used for "Check display", "Equal allotment", and "Shift amount in Z direction". Unless "0" or more value is set to the X and Y parameters respectively, the "Check display" function cannot be executed. Setting range: 0 to 6,000 mm Default value: 0
Origin offset	Used to specify a distance between the loading (unloading) point of the first workpiece and the home position of user coordinate. Setting range: -3,000.0 to +3,000.0 mm Default value: 0.0 mm
Layer	Used to make setting of the number of layers of workpieces to load. Note: To make setting of depalletizing (extraction), set the number to layers to a negative value. Setting range: -50 to +50 Default value: 0
Workpiece dimensions	Used to make setting of workpiece dimensions (A: Length, B: Height, C: Width (short side), and D: Width (long side)). For detail, refer to Fig. 4.5.2 Workpiece dimensions. Setting range: 0.0 to 999.9 mm Default value: 0.0 mm
Location pattern	Used to make setting of location pattern number to use. Setting of data for the number of layers set by the Layer parameter must be made. Setting range: 0 to 100 Default value: 0
Base shift amount in Z direction	Used to make setting of base shift amount in the Z direction for each layer. Setting range: -9,999.9 to +9,999.9 mm Default value: 0.0 mm



To clear location palletizing data, press the f10 key [Clear].

>> The message "Is it OK to clear the data?" will be displayed. Select "Yes".

4.6 Monitoring the loading status on the check display

Based on the data which was set on the complex palletizing detailed setting screen, the loading status of the workpieces on the pallet can be graphically displayed for each level in turn or for two levels.

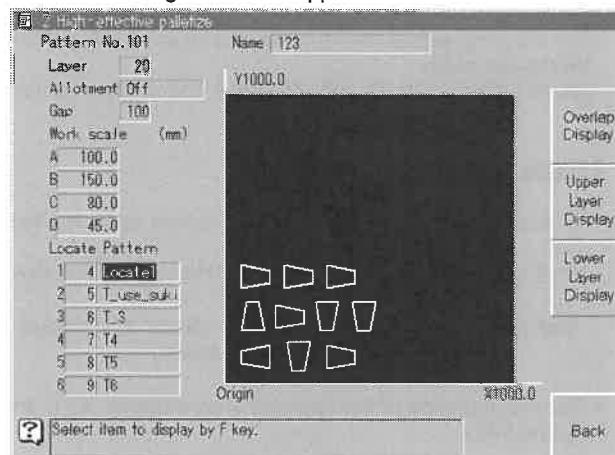
It is recommended that this loading status be checked before saving the data set on the complex palletizing detailed setting screen and before executing the palletizing tasks.

While in "Shift value" mode, if any workpiece position is taken as the home position and the workpiece position setting is made by a shift amount from this home position, the Check display will be corrected so that no workpieces will stick out from the pallet since the exact location of the pallet is unknown. Consequently, the loading conditions on the Check display are different from the actual loading conditions. Take the loading conditions on the Check display just as a guideline.



- 1 Press f key <Check Display> on the complex palletizing detailed setting screen.**

>> The following screen will appear.



How the workpieces are actually loaded is displayed in the form of the XY plane view of the workpieces mounted on the pallet.

The display scale differs depending on the dimensions of the pallet.

<<Caution>>

Workpieces sticking out from the pallet will be drawn in yellow.



- 2 When the f8 [Overlap Display] key is pressed, the pattern of the workpieces on the level below the level whose workpiece pattern is currently displayed is superimposed in purple.**

When the key is pressed again, the display of the workpieces on a single level (without the level below superimposed upon it) is restored.

<<Caution>>

Workpieces sticking out from the pallet will be drawn in yellow.



- 3 When the f9 [Upper Layer Display] key is pressed, the level whose layout pattern is to be displayed moves up by one.**



- 4 When the f10 [Lower Layer Display] key is pressed, the level whose layout pattern is to be displayed moves down by one.**



- 5 When the f12 [Back] key is pressed, the complex palletizing detailed screen is restored.**

4.7 Shift amounts

For highly effective palletizing, shift amounts to execute palletizing are found by the following calculation formulas.

1. While in "Work Scale/Gap" mode:

Shift amount in the X direction = $XA \times A/2 + XD \times D/2 + XS1 \times \text{Gap} / 100 + XS2$
 + Tool offset in the X direction – Home position offset in the X direction

Shift amount in the Y direction = $YA \times A/2 + YD \times D/2 + YS1 \times \text{Gap} / 100 + YS2$
 + Tool offset in the Y direction – Home position offset in the Y direction

Shift amount in the Z direction = $B \times \text{Number of layers} + \text{Pallet set value in the Z direction} + \text{Tool offset in the Z direction}$

* For the purposes of the formulas shown above, A = Workpiece length, B = Workpiece height, and D = Workpiece width.

XA, XD, XS1, XS2, YA, YD, YS1, and YS2 represents the set value of location data, respectively.

2. While in "Shift value" mode:

Shift amount in the X direction = $X - (\text{Home position offset in the X direction})$

Shift amount in the Y direction = $Y - (\text{Home position offset in the Y direction})$

Shift amount in the Z direction = $Z + (\text{Base shift amount in the Z direction}) + (\text{Pallet set value in the Z direction})$

* For the purposes of the formulas shown above, X, Y, and Z represent the set values of location data, respectively.

About home position offset

While in both "Work Scale/Gap" and "Shift value" modes, the home position shift amounts in the X and Y directions are deducted from the shift amounts.

Consequently, if the workpiece position setting is made by a shift amount from the home position of pallet while in "Work Scale/Gap" and "Shift value" modes, the offset value from the palletizing home position of the workpiece must be set to the home position offset by conducting teaching for any workpiece in the process in which palletizing (shift) is executed.

Furthermore, if any workpiece position is taken as the home position and the workpiece position setting is made by a shift amount from this home position while in "Shift value" mode, the home position offset value must be set to "0" by conducting teaching for workpiece, the position of which was taken as the home position.

Chapter 5 Teaching

This chapter describes the teaching procedures for complex palletizing. Palletizing is accomplished by combining a number of application commands (functions).

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5.1 General description of teaching

The palletizing is recorded in task programs using application commands (functions).

Palletizing start, end, etc. are specified, using parameters such as the palletizing numbers defined by simple palletizing or complex palletizing.

The application commands which are used are listed in the table below. Details on each command can be found on the following pages.

Table 5.1.1 Application commands used by palletizing

FN code No.	Name of FN command	Outline
47	Palletize start	This is used to start the palletizing work for the palletizing number specified.
48	Palletize end	This is used to end the palletizing work for the palletizing number specified.
49	Palletize reset	When a condition signal has been input, the palletize counter for the palletizing number specified is forcibly reset (operation is forcibly terminated).
65	Direction select palletize	This makes it possible to select the direction in which to shift the workpieces in the course of the palletizing task.

5.2 FN47 Palletize start, FN48 Palletize end

5.2.1 General description of function

FN47 is the palletize start command.

Palletizing is started with this application command. "Palletizing operations" involve calculating the shift amount based on the specified palletizing number and palletize counter and playing back the positions which have been offset from the original positions by the shift amount. These shift operations continue until the next "FN48 Palletize end" application command is executed.

Mnemonic	Number	Command
PALLET2	FN47	Palletize start

Parameter	Data	Description, setting range
First parameter	Palletize No	This specifies the palletizing number to be executed. (1 to 200)

FN48 is the palletize end command. This is paired with the "FN47 Palletize start" command.

It ends the palletizing pattern being executed, and increments the palletize counter by 1. If, as a result of the incrementation, the palletize counter has exceeded the total number of workpieces for the palletizing specified, the tasks for all the workpieces are considered to have been completed, and this fact can be relayed to an external device by setting the specified general-purpose output signal to ON.

Mnemonic	Number	Command
PALLET2_END	FN48	Palletize end

Parameter	Data	Description, setting range
First parameter	Palletize No	This specifies the number of the palletizing operation which is to be ended. (1 to 200)
Second parameter	Output signal	This specifies the number of the output signal. When all the palletizing tasks specified have been completed, the general-purpose output signal specified is set to ON. (0 to 2048)

5.2.2 Example of operation

Record the black circles in the figure and then the "FN47 Palletize start" and "FN48 Palletize end" commands. When this program is played back, the workpieces are placed on the pallet at the target positions while the recorded positions are each shifted in turn. (Paths traced by dotted lines)

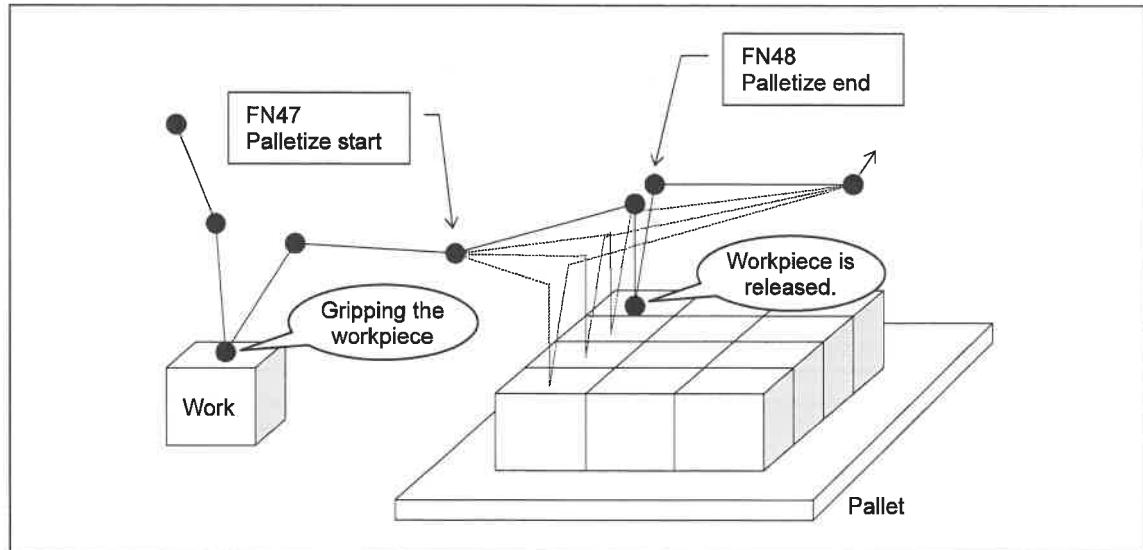


Fig. 5.2.1 Example of operations from "FN47 Palletize start" and "FN48 Palletize end"

5.3 FN49 Palletize reset

5.3.1 General description of function

Using this application command, the palletize counter can be forcibly reset if the specified palletizing task is being executed and the condition signal (general-purpose input signal) is ON.

It is also possible to output the fact that the palletizing has been reset, using the specified general-purpose output signal as the palletize acknowledge signal. Furthermore, operation can be made to jump to a specified step.

If the setting of [6 Palletize acknowledge] under [22 Handling Application] – [1 Handling Conditions] selected from Service Utilities is <Enabled>, the palletize acknowledge signal is output as soon as the application commands is played back even without resetting the palletizing.

There is no specific OFF timing for this signal. It is set to OFF when step 0 is played back or OFF has been specified by another application command.

Mnemonic	Number	Command
PALLET2_RESET	FN49	Palletize reset
Parameter	Data	Description, setting range
First parameter	Palletize No	This is used to specify the palletizing number for which the counter is to be reset. (1 to 200)
Second parameter	Input signal number	This is used to specify the number of the input signal serving as the condition for resetting the palletizing. By specifying numbers from 5101 to 5196, a multiple number of input conditions can be specified. (1 to 5196)
Third parameter	Acknowledge signal	This is used to specify the number of the output signal (acknowledge signal) which indicates that the palletizing has been reset. (1 to 2048)
Fourth parameter	Step No.	This is used to specify the number of the jump destination step. Operation jumps to the step specified here only when palletizing has been reset. (0 to 9999)

5.3.2 Example of operation

As shown in the figure below, if the general-purpose input signal serving as the condition for the resetting is set to ON when FN49 is executed, the palletize counter is reset and operation jumps to the specified step. (Path traced by broken line)

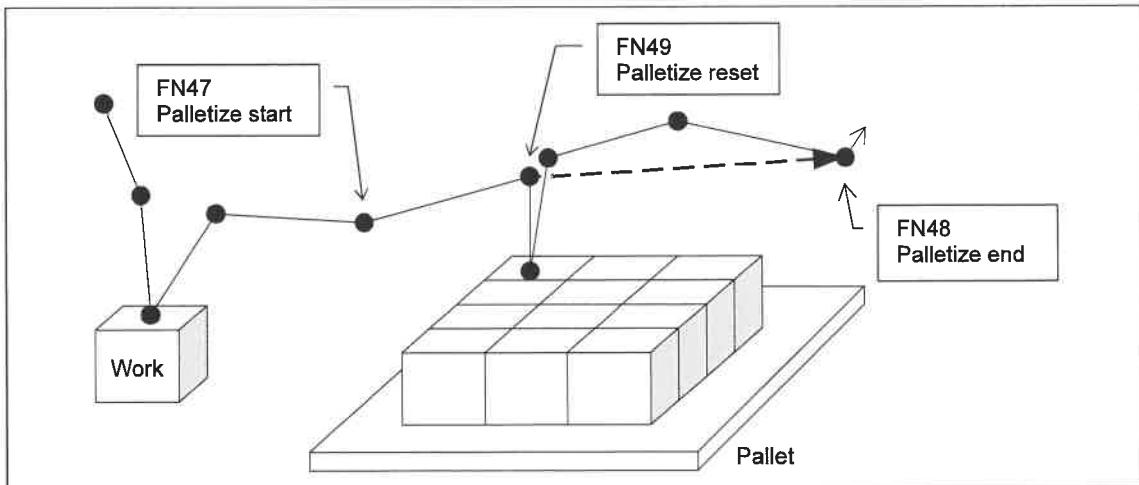


Fig. 5.3.1 Example of "FN49 Palletize reset" operation

5.4 FN65 Direction select palletize

5.4.1 General description of function

The direction in which the position is to be shifted during the palletizing tasks can be specified using this application command.

Mnemonic	Number	Command
DSPALLET	FN65	Direction select palletize
Parameter	Data	Description, setting range
First parameter	Palletize No	This specifies the palletizing number to be executed. (1 to 200)
Second parameter	Shift direction No.	<p>This is used to specify the shift direction. The shift direction numbers are as follows. Here all the X, Y and Z values denote the values used in the user coordinate system. (0 to 6)</p> <ul style="list-style-type: none"> 0: All directions (Same shift as with FN47) 1: XY plane (Only X and Y values for shift amounts used) 2: YZ plane (Only Y and Z values for shift amounts used) 3: ZX plane (Only Z and X values for shift amounts used) 4: X direction (Only X value for shift amounts used) 5: Y direction (Only Y value for shift amounts used) 6: Z direction (Only Z value for shift amounts used)

5.4.2 Example of operation

As shown in the figure below, when "FN47 palletize start" is used, shifts are normally made in each of the X, Y and Z directions with respect to the user coordinate system. However, if there is an obstacle at some point above in the Z direction or if the environment is otherwise such that shifting must not be initiated in a fixed direction, the "FN65 Direction select palletize" command is used as shown in the figure below on the right.

In this example, the shift operation is undertaken only in the X and Y directions of the user coordinate system.

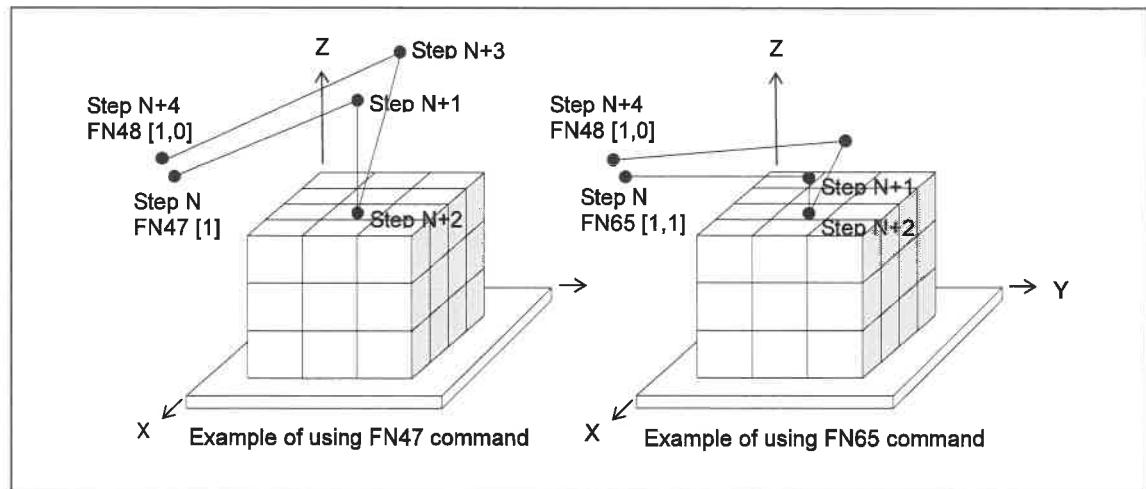


Fig. 5.4.1 Example of "FN65 Direction select palletize" operation

5.5 Teaching for multiple palletizing

Multiple palletizing refers to performing additional palletizing operations during ongoing palletizing operations.

It refers, for instance, to a palletizing task such as the placement of four small boxes inside each of the large boxes already placed on the pallet, as shown in the figure below. What happens is that the palletizing task for the small boxes is performed during the palletizing task for the large boxes.

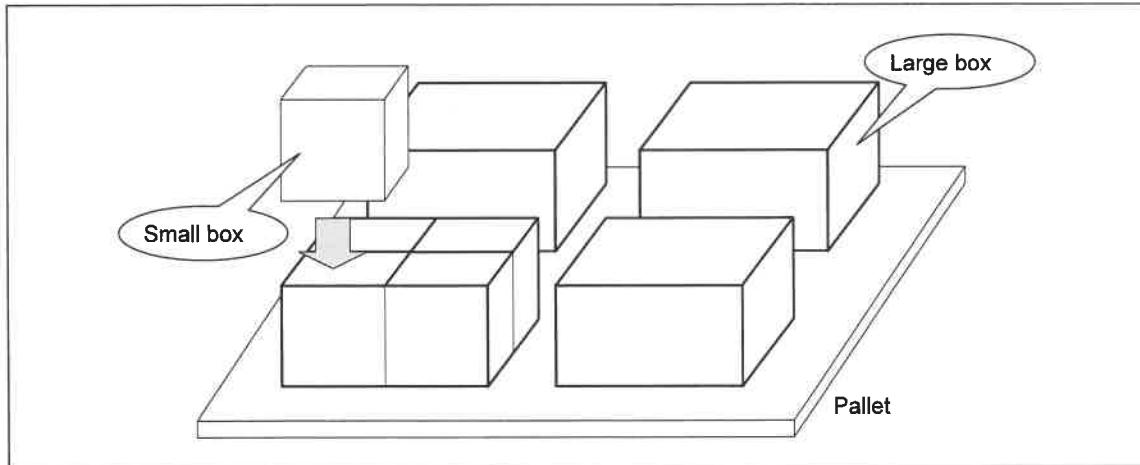


Fig. 5.5.1 Multiple palletizing

If, when this kind of multiple palletizing is undertaken, and if 101 is assigned as the palletizing number for the large boxes and 102 is assigned as the palletizing number for the small boxes, palletizing start and end are recorded as shown below. By repeating this, the palletizing task shown in the figure above can be accomplished.

When multiple palletizing has been undertaken, each shift amount can be specified for each user coordinate system.

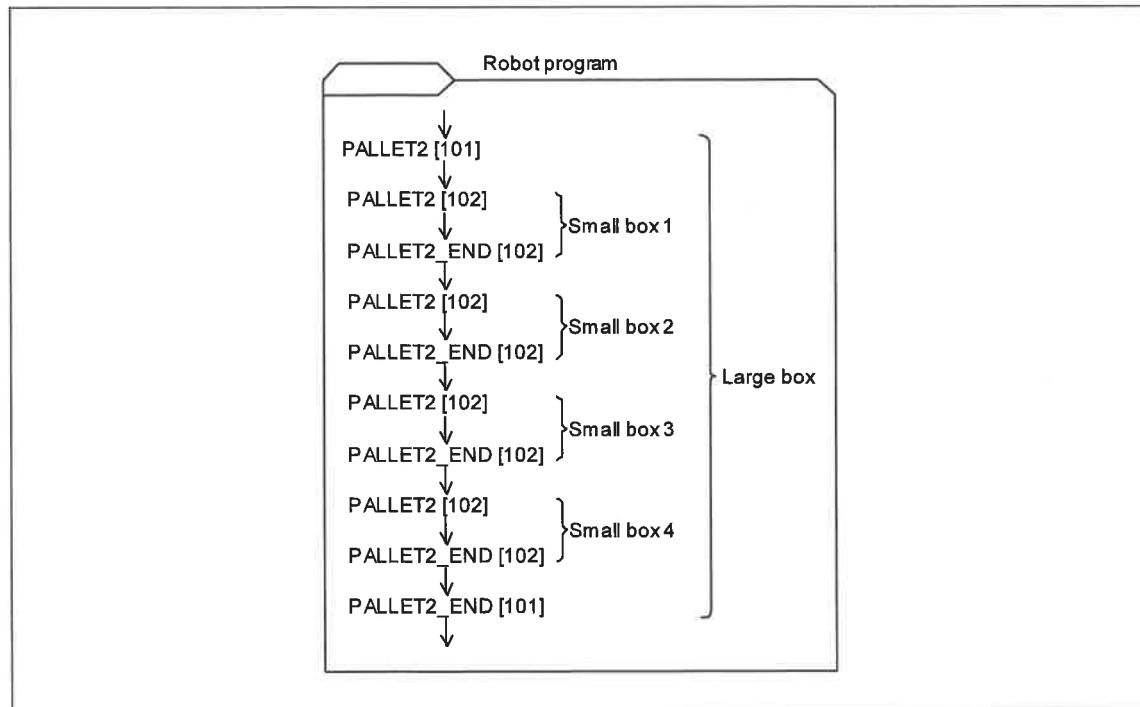


Fig. 5.5.2 Teaching for multiple palletizing

Chapter 6 Motion checks and operation

This chapter describes the useful functions used for motion checks and while palletizing operations are underway.

6.1 Monitoring the current statuses.....	6-1
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6.3.2 Presetting from the Service Utilities menu	6-5
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6.1 Monitoring the current statuses

1 Select the or [PLAYBACK] mode or [TEACH] mode

2 Open [Service Utilities][3/4/5/6 Monitor 1/2/3/4][14 Handling monitor][3 Palletizing] monitor.

>> The following screen will appear.



Item	Description
Number at far left	This is a running number that indicates the numerical sequence in which the execution of the palletize start commands has been started. In the example given, the display shows that five palletizing operations are being executed simultaneously (or as multiple palletizing). When a palletizing operation ends (when the pallet is fully loaded or the present count equals the total count), the line for that operation is cleared.
No.	This is the number of the palletizing being executed. If the number is 100 or under, it denotes a simple palletizing operation; if it is 101 or above, it denotes a complex palletizing operation.
Cur	This is the palletize counter. It shows the number of the workpiece now being palletized. It is incremented when the "FN48 Palletize end" command is executed.
Total	This is the total number of workpieces to be loaded by the corresponding palletizing number.
Name	This is the name given to the palletizing number.

6.2 Ending palletizing at an interim point

If, for some reason or other, the decision has been made to end the palletizing at an interim point or, in other words, not to continue with the subsequent palletizing operations while the pallet is not fully loaded with workpieces, the palletize counter that reflects an interim figure must be forcibly cleared in order for the palletizing task to be started from the first workpiece in the next operation. The steps taken to achieve this are described in this section.

The palletize counter can be reset in a number of ways, each of which is described below.



CAUTION

Take care when starting operation for the first time after the palletize counter has been reset or preset. If the figure on the counter is the wrong one, unforeseen trouble such as interference with surrounding objects may occur.

6.2.1 Forcibly ending palletizing with a shortcut R code

"R55 Palletize counter reset" is available as an R code to be used exclusively for the palletizing function. Using this code, the palletizing now underway can easily be reset manually.

The code cannot be used during robot playback.

Shortcut	Description	
R55	Palletize counter reset	
<hr/>		
Parameter	Data	Description, setting range
First parameter	Palletize No	This is used to specify the palletizing number for which the palletize counter is to be reset. When "0" is specified, all the palletize counters are reset. (0 to 200)

Bear in mind that when the palletizing now being executed by the "FN47 Palletize start" command has been reset by R55, if the "FN48 Palletize end" command recorded after the start command is then executed, alarm 2201 will result and the playback operation will be suspended since the palletize counter has already been reset by R55.

6.2.2 Forcibly ending palletizing from the Service Utilities menu

A menu option enabling the palletize counter value to be reset is provided with Service Utilities/Handling Application: this is used to forcibly ending palletizing. Not only is resetting possible: a specific number can also be preset.

- 1 First, stop the robot now in the playback operation.
The palletize counter cannot be reset or preset while the robot is operating.
- 2 If the robot is already in the playback mode, leave the mode as is or establish the teach mode.



- 3 Open [Service Utilities] [2 Palletize count preset] [22 Handling Application] screen.**

>> The following screen will appear.

No.	Palletize No.	Palletize name	Present count	Total count
1	150	GAP-FIX	3	20
2	155	GAP-FIX	9	20
3	160	GAP-NONE	10	20
4	171	GAP170%	18	20
5	180	GAP+FIX	4	20

Set value which you preset within the total count. [0 - 20]

Addition Execute

The data displayed represents the information available at the time when the screen is displayed. Since this is not a monitor screen, the data is not updated on a real-time basis.

Item	Description
No.	This is a running number that indicates the numerical sequence in which the execution of the palletize start commands has been started. In the example given, the display shows that five palletizing operations are being executed simultaneously (or as multiple palletizing). When a palletizing operation ends (when the pallet is fully loaded or the present count equals the total count), the line for that operation is cleared.
Palletize No.	This is the number of the palletizing being executed. If the number is 100 or under, it denotes a simple palletizing operation; if it is 101 or above, it denotes a complex palletizing operation.
Palletize name	This is the name given to the palletizing number.
Present count	This is the palletize counter. It shows the number of the workpiece now being palletized. It is incremented when the "FN48 Palletize end" command is executed. This figure can be reset or preset manually.
Total count	This is the total number of workpieces to be loaded by the corresponding palletizing number.



- 4 Align the cursor with the [Present count] field of the palletizing number concerned, input [0], and press [Enter].**

Input "0" for all the numbers concerned if more than one palletizing operation is to be forcibly terminated.

Special care is required if multiple palletizing is being executed. Set "0" for all the palletizing numbers which are to be forcibly terminated at the same time.



- 5 Finally, press the f12 [Execute] key.**

>> At this time, the new palletize counter figure which has been set takes effect. If "0" is set for present count, the palletizing task concerned is forcibly terminated. (This cannot be done on the palletizing monitor.)

6.3 Starting palletizing at an interim point

If palletizing is to be resumed from an interim point for some reason or other, the palletize counter must be forcibly changed (or preset) to the desired value. The steps taken to achieve this are described in this section.

The palletize counter can be preset in a number of ways, each of which is described below.



CAUTION

Take care when starting operation for the first time after the palletize counter has been reset or preset. If the figure on the counter is the wrong one, unforeseen trouble such as interference with surrounding objects may occur.

6.3.1 Starting palletizing at an interim point

If the palletizing number concerned has not been executed at all or if the pallet is already fully loaded, the palletizing number is not registered in the palletize table.

In other words, the palletize counter cannot be preset since the input field is not displayed on the screen shown in "6.2.2 Forcibly ending palletizing from the Service Utilities menu".

At a time like this, proceed as follows to start the desired palletizing from an interim point.

- 1 First, stop the robot now in the playback operation.
The palletize table cannot be inserted while the robot is operating.**

- 2 If the robot is already in the playback mode, leave the mode as is or establish the teach mode.**

- 3 Open [Service Utilities] [22 Handling Application] [2 Palletize count preset] screen.**



2 Palletize count preset					
No.	Palletize No.	Palletize name	Present count	Total count	Addition
1	150	GAP-FIX	5	20	
2	155	GAP-FIX	9	20	
3	160	GAP-NONE	10	20	
4	171	GAP170%	18	20	
5	180	GAP+FIX	4	20	

- 4 In the example given, five palletizing operations are currently being executed.
Press f key <Addition> to start a new (sixth) palletizing operation from an interim point.**

>> The following screen will appear.

2 Addition of palletize work	
Set the palletize number to add. [1 - 200]	
<input type="text"/>	

- 5 Input the palletizing number to be added, and press [Enter].**
Input a number 100 or under for simple palletizing and a number 101 or above for complex palletizing.
 >> If, for instance, palletizing number 2 (simple palletizing) has been added, the new palletizing operation will be displayed at the bottom (No.6) of the palletize table as shown below.

No.	Palletize No.	Palletize name	Present count	Total count	Addition
1	150	GAP-FIX	3	20	
2	155	GAP-FIX	9	20	
3	160	GAP-NONE	10	20	
4	171	GAP170%	18	20	
5	180	GAP+FIX	4	20	
6	2	S-PTN2	1	1	

- 6 "1" appears as the present count.**
Since palletizing would be executed from the first workpiece if the "FN47 Palletize start" command were played back with no further action taken, input the desired number of the workpiece with which the palletizing is to start, and press [Enter].
To resume palletizing with the eighth workpiece, input "8."
- 7 Finally, press f key <Execute>.**
- 8 The operation is resumed.**
 >> When the "FN47 Palletize start" command is played back next time, palletizing is executed from the workpiece specified in step 6.

6.3.2 Presetting from the Service Utilities menu

To change a palletize counter while palletizing is being executed, that is to say, to change the palletize counter for the palletizing listed on the palletize table, all that needs to be done is preset the value in the desired palletize counter by selecting [2 Palletize count preset] from Service Utilities/[22 Handling Application].

Following the same procedure as in "6.2.2 Forcibly ending palletizing from the Service Utilities menu", input a figure (but not "0") for the desired number of the workpiece.

6.3.3 Presetting from the monitor screen

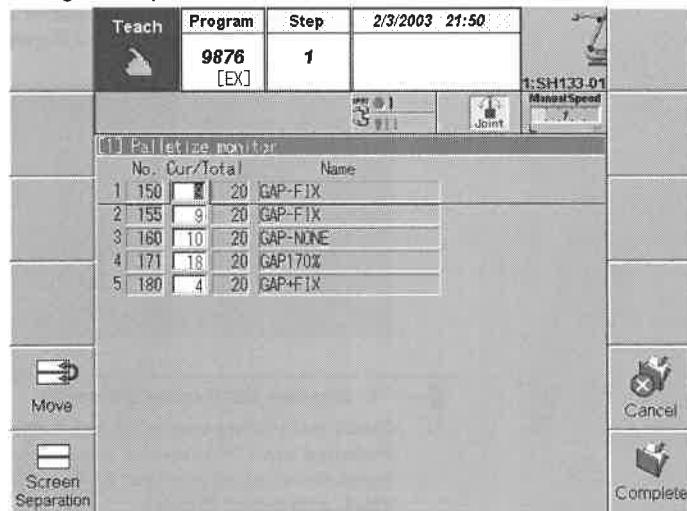
A figure can be input directly into a particular palletize counter from the palletizing counter monitor screen shown in "6.1 Monitoring the current statuses".

- 1 First, stop the robot now in the playback operation.**
The palletize table cannot be inserted while the robot is operating.
- 2 If the robot is already in the playback mode, leave the mode as is or establish the teach mode.**
- 3 Open [Service Utilities] [3/4/5/6 Monitor 1/2/3/4] [14 Handling monitor][3 Palletizing] monitor.
 [3 Palletizing] to display the palletize counter monitor screen. If multiple monitor screens are already displayed, press the [SELECT SCREEN] key to activate the palletize counter monitor screen.**



4 Press the [EDIT] key.

>>The title bar of the palletize counter monitor screen turns red to indicate that editing is now possible.

**5 Align the cursor with the "Cur" field for the desired palletizing, input the number of the workpiece with which the palletizing is to start, and press [Enter].**

To resume palletizing with the eighth workpiece, input "8."

A figure exceeding the total number of workpieces or "0" cannot be input.

6 Upon completion of the settings, press the key <Complete>.

>> Operation now returns to the palletize counter monitor screen. The data set has already been reflected.

7 The operation is resumed.

>> When the "FN47 Palletize start" command is played back next time, palletizing is executed from the workpiece specified in step 5.

Chapter 7 Troubleshooting

This chapter explains troubleshooting for the palletize function.

7.1 Table of Error Codes 7-1

7.1 Table of Error Codes

The following is the table of error codes related to palletize function.

No.	A2201 (Alarm)
Message	Palletize-end does not follow Palletize function.
Cause	This error occurs when a palletize-end function (M47) does not follow Palletize function (M48).
Countermeasure	Correct the sequence of Palletize and Palletize end functions in the program.
No.	A2202 (Alarm)
Message	More than 32 Palletizing routines not allowed.
Cause	More than 32 Palletizing routines not allowed.
Countermeasure	Please refer to Palletize function manual for details.
No.	A2203 (Alarm)
Message	Palletize data is abnormal.
Cause	This error occurred calculate shift value is failed from palletize data.
Countermeasure	Please refer to palletize data.
No.	A2204 (Alarm)
Message	Multiplex palletize over.
Cause	This error occurred multiplex palletize beyond 8 is carried out.
Countermeasure	Please confirm a robot program.
No.	A2173 (Alarm)
Message	Shift value limit exceeded.
Cause	This error occurs if the allowable shift distance is too large.
Countermeasure	Reset the limit value [Constants][Shift limit & evaluation value] and retry program.

7.1 Table of Error Codes

Note



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NACHI NORTH AMERICA

<http://www.nachirobotics.com/>

North America Headquarters	Phone: 248-305-6545	Fax: 248-305-6542	22285 Roethel Drive, Novi, Michigan 48375 U.S.A.
Greenville Service Office	Use 248-305-6545	Use 248-305-6542	South Carolina, U.S.A.
San Antonio Service Office	Use 248-305-6545	Use 248-305-6542	Texas, U.S.A.
Kentucky Branch Office	Phone: 502-695-4816	Fax: 502-695-4818	116 Collision Center Drive, Suite A, Frankfort, KY 40601 U.S.A
Training Office	Phone: 248-334-8250	Fax: 248-334-8270	22213 Roethel Drive, Novi, Michigan 48375 U.S.A.

Toronto Branch Office	Phone: 905-760-9542	Fax: 905-760-9477	89 Courtland Avenue, Unit 2, Vaughan, Ontario L4K3T4 CANADA
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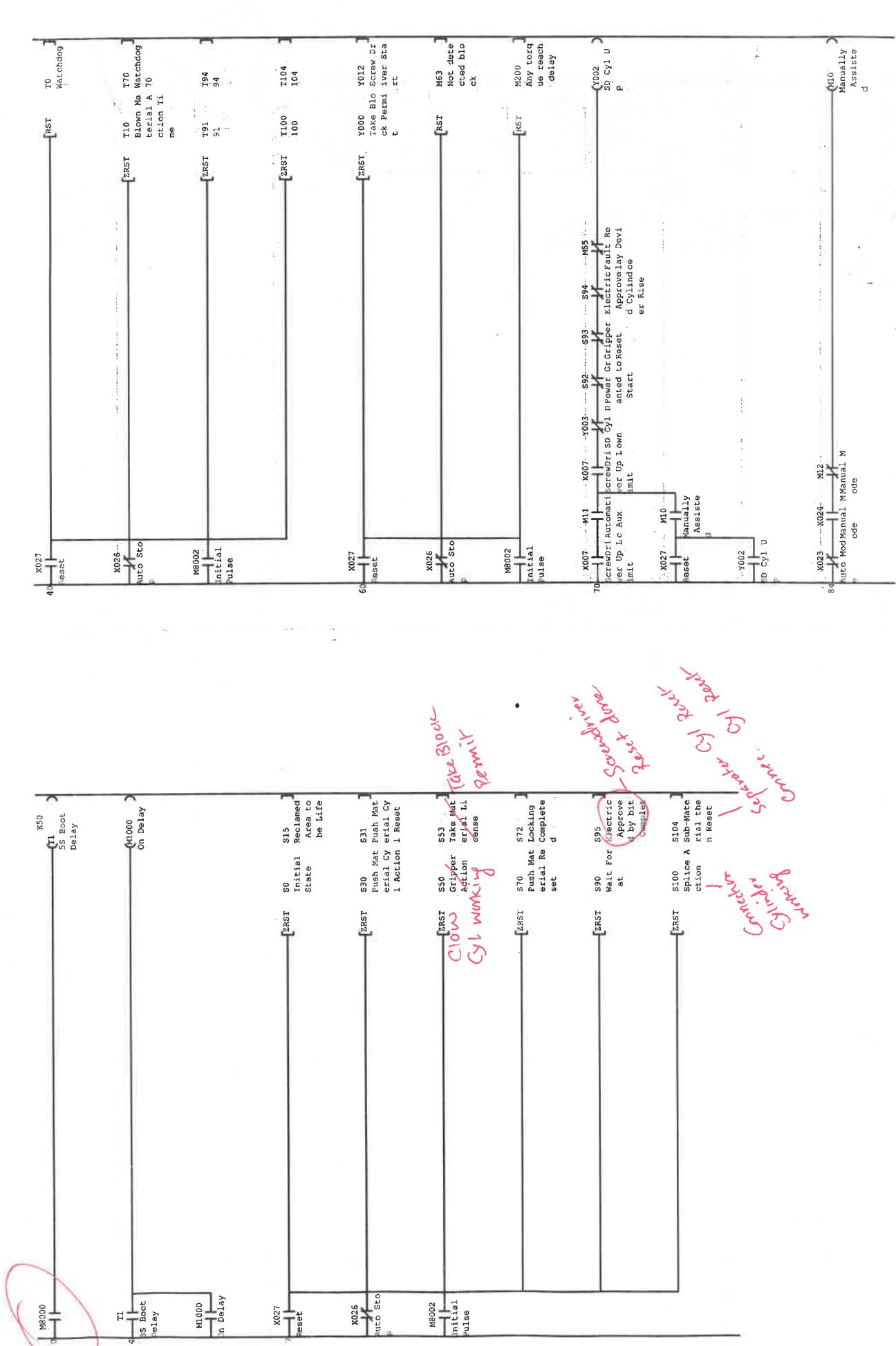
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