STEP Robot Palletizing Instruction Manual

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ADTECH TECHNOLOGY CO., LTD. is fully responsible for the development and print of this control system user operation and programing guide.

Foreword

Abstract

This manual provides complete and comprehensive description about STEP robot palletizing function. This manual can be used as the guidance for palletizing function of STEP robot.

In order to ensure proper use the palletizing function of STEP robot, be sure to read this manual carefully before using the robot.

Target Readers

Operator

Robot programmer

Engineering maintenance personnel

Technical support personnel for users

Contents

Contents in this manual may be supplemented and modified, please visit our website to update your manual. Our website: www.steprobots.com.

Main features

The screen of STEP robot teach pendant adopts hierarchical and classified management type, the users could control the robot with the physical buttons on the teach pendant and the virtual hotkeys on the touchscreen. The operation screen is concise, and the using method conforms to human senses, it's easy to understand.

Descriptions of safety-related marks

In this operation manual, the contents relating to safety will apply the following marks. Descriptions and contents with safety mark are important, please be sure to observe them.

Danger

It may cause hazardous conditions or personal death if it is used improperly.

Caution

It may cause danger, minor or serious personal injury and equipment damage if it is used improperly.

Important The part that the user needs to observe and pay attention.

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Chapter I Description

1.1 Purpose

The document is aimed to describe the function, operation method and notice for use of palletizing. The document can help users quickly learn how to use the feature pack of palletizing.

1.2 Target groups

The audient of the document is: robot operator, programmer, maintenance personnel, robot integrator. The following is other skills required by target groups.

Table 1.1 Target group and required skills

Target group	Required skills
Operator	Participate in the robot training and get qualified certificate, be familiar with robot operation.
Programmer	Have robot programming basis, be familiar with robot function.
Maintenance personnel	Be familiar with robot function and electrical schematic.
Integration personnel	Be familiar with robot function and application.

1.3 Other related documents

STEP Robot Operating Software Instruction Manual

1.4 Precautions

This manual mainly introduces the feature pack of palletizing, for the details of the basic robot operation, please refer to the relevant document.

Chapter II Safety

2.1 Safety protective device of the robot

2.1.1 Overview

The following safety protective devices are provided on robot system:

- Emergency switch-off key
- Selection switch of operation mode
- Jogging operation
- Mechanical end stop
- Software limit switch

Note: when the safety protective device is dismantled or stopped, the robot system is forbidden to run.

2.1.2 Emergency switch-off key

The emergency stop button is located on the control panel of the teach pendant. When the button is pressed, the robot's drive is shut down immediately.

Danger The emergency stop button shall be pressed immediately if any accident occurs what will endanger personnel or equipment. To resume the operation, turn the emergency stop button to unlock it and acknowledge the shut-down information.

2.1.3 Selection switch of operation mode

There are 3 operation modes for the robot: fast manual operation (T2), automatic operation (AUT) and automatic external operation (AUT EXT).

The operation mode is selected using the key switch on the panel. If the operation mode is changed during the movement of the robot, the drive is disrupted immediately.

Table 2.1 Robot Operation Mode

Operation mode	Application	Speed
T2	For testing operation	Programming running: without speed limit requirement; Jogging operation: max. speed is 250mm/s
AUT	For the robot system without higher level control system	Programming running: without speed limit requirement; Jogging operation: unable to run
AUT EXT	For the robot system with higher level control system (such as PLC)	Programming running: without speed limit requirement; Jogging operation: unable to run

2.1.4 Jogging operation

Important When a program is developed, the program teaching and debugging shall be done in manual mode and no error occurs before it can be run in automatic mode. It is called jogging operation when the program is run in manual mode.

Difference between automatic operation program and jogging operation program:

- In automatic running mode, press “Start” button to run the program. In manual mode, press and hold “Start” button to run the program. The robot stops running when the “Start” button is released.
- It is safer to run the program in manual mode as there is stricter limit on the running speed.

2.1.5 Mechanical end stop

The basic axes A1, A2, A3, A5 and A6 are provided with mechanical end stop with buffer.

2.1.6 Software limit switch

Caution The movement range of all the axes of the robot can be limited by the defined software limit switch. The software limit switch only serves as mechanical safety device, and is so defined that the robot will not collide the mechanical end stop.

2.2 Relevant personnel

Important All the working personnel relating to the robot control system shall read and be familiar with the documents on the safety of the robot system.

Before the work, the working method, range and potential hazard shall be introduced to the working personnel. Describe them aging after accident or technical update.

The relevant personnel include the system integrator that integrates the robot system into the equipment, user, operator or the programmer of the robot system.

2.3 Training

The user that uses the robot and the robot system shall ensure that its programmer, operator and maintenance personnel have participated in the safety training, and acquired corresponding capabilities to undertake the work. For the training, it's better to combine classroom courses with practical operation.

Objective:

The goal of the training is to help the trainees understand the following information:

1) Usage and function of safety components;
2) Procedures concerning health and safety;
3) All danger caused by the operation of robot or robot system;
4) Task and purpose related with specific robot;

5) Basic safety concept.

Requirement:

1) Learn applicable safety procedures and safety suggestions provided by the robot manufacturer and the robot system designer;

2) Understand the clear meaning of the task assigned;

3) Master the identification and description of all control units and their functions that are used to complete the assigned task, such as slow speed control, teach box operation, emergency stop procedure, switch-off procedure, single point control and etc.;

4) Identify the danger related to the task, including the danger caused by the auxiliary equipment;

5) Identify the safety protective devices, including the type, capability or selection scheme of the safety protective devices, function of the components selected, functional test method of the components, limit of the components selected and the safety operation procedures since identifying danger, personnel protection equipment and etc.;

6) Master the test method to ensure the normal function of safety protective devices and interlocking units;

Re-training requirement:

In case system change, personnel change or accident occurs, in order to ensure safe operation, relevant personnel should participate in training again.

2.4 Safety measures

Caution The robot system can only be operated with the equipment functioning properly and with proper safety awareness. Improper application may lead to personnel injury and equipment damage.

Even if the robot control system is shut off with safety protection, there still could be movement of the robot system. Improper installation (such as overload) or mechanical damage (such as brake failure) could cause settlement of the robot or auxiliary axis. If the work is performed on the robot system that has been shut off, the robot and the auxiliary axis shall move to a state where they will not move on their own with or without load. If the above conditions cannot be met, proper protection shall be provided for the robot and auxiliary axis.

Execute the following when the robot system has any fault:

- Shut off the robot control system and protect it well, to prevent unauthorized restart.
- Indicate the fault by the nameplat3e with corresponding prompts.
- Record the fault.
- Troubleshoot and have functional check.

Chapter III Palletizing variables

3.1 Variables overview

The palletizing variables must be newly created in the variables screen, and only be created under the Global folder.

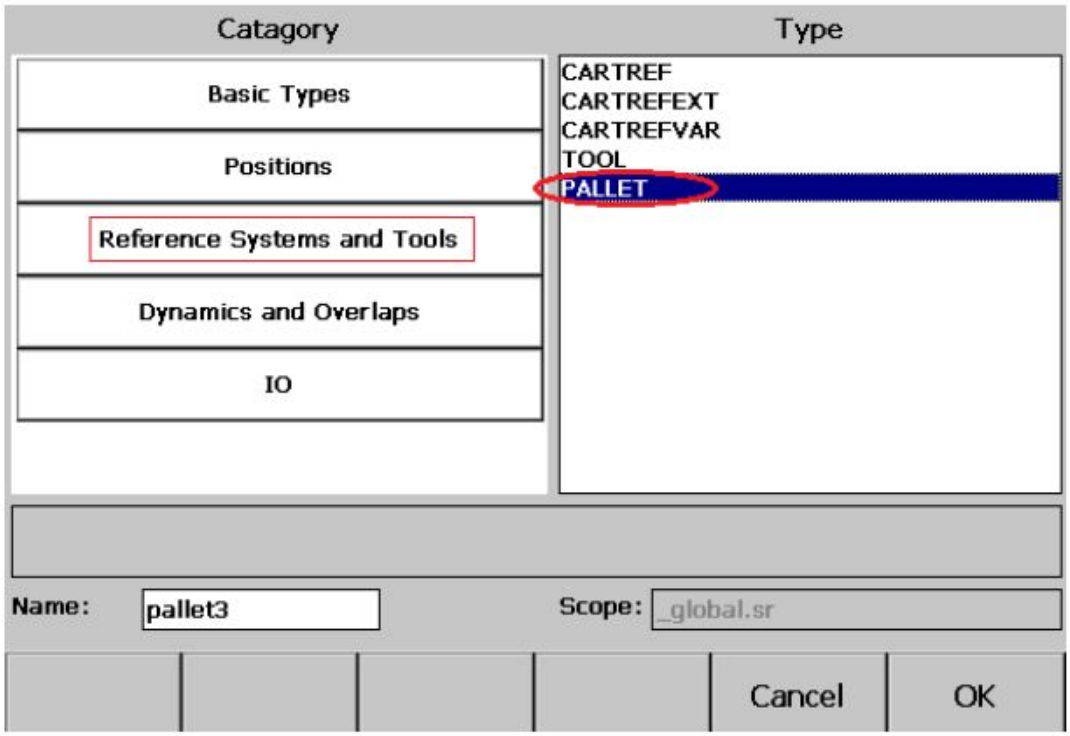
One palletizing variable includes the information required by all palletizing modules. Through the palletizing variables, the robot could calculate all palletizing points and other information required during the palletizing process, mainly includes:

- Starting point of palletizing
- Information quantity of entry point
- Number of parts in directions X, Y and Z
- Distance between parts (in directions X, Y and Z)
- Palletizing order
- Placement direction of parts
- Information of pre-place position and post-place position
- Reference coordinate system of palletizing

3.2 Variable creation and view

3.1.1 Palletizing variable creation

In the left side of the "New" screen select "Reference Systems and Tools", then in the right side select "PALLET", input the variable name, and click "OK" to complete the new creation of palletizing variable "PALLET". Schematic of variable new creation is as follows:

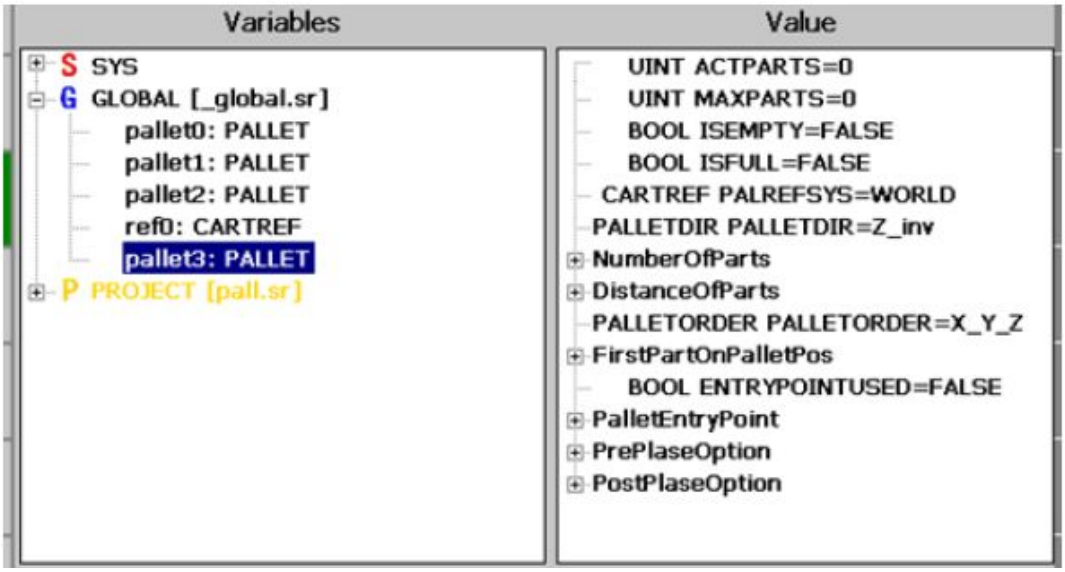


Palletizing variable creation

Note: When a palletizing variable is newly created, only "global" could be selected for "scope", that is to say the palletizing variable could only be a global variable under "global".

3.1.2 Palletizing variable view

After a palletizing variable is newly created, it could be viewed in the "global" variables or previewed in the configuration screen.



Palletizing variable view

The meaning of each parameter in each variable is as following:

- **ActParts** (actual number of parts)

This data is used to indicate the actual quantity of parts, to determine the starting position of palletizing or depalletizing.

- **MaxParts** (maximum number of parts)

This data describes the expected total quantity of parts to be palletized or depalletized, which is only automatically calculated with system, couldn't be modified directly.

- **IsEmpty** (pallet is empty)

  This data describes if there is part in the current pallet, if the pallet is empty, the value of "IsEmpty" is TRUE, otherwise, the value of "IsEmpty" is False.

- **IsFull** (pallet is full)

  This data describes if the current pallet is full of parts, if the pallet is full, the value of "IsFull" is TRUE, otherwise is False.

- **PalRefSys** (Reference coordinate system of palletizing)

  PalRefSys is an essential parameter in palletizing, all point position (firstPartOnPalletPos, PalletEntryPoint) data is relative to PalRefSys. Note: **PalRefSys** must be a fixed coordinate system (**CARTREF**) type or **WORLD**.

- **PalletDir** (placement direction of palletizing)

  PalletDir is used to calculate the pre-place position and post-place position of palletizing, therefore if pre-place position and post-place position are not used, PalletDir is invalid. The value of PalletDir could be: X_inv, X_reg, Y_inv, Y_reg, Z_inv or Z_reg.

- **NumberOfParts** (number of parts in each direction of palletizing)

  NumberOfParts (three values) describes the number of parts in directions X, Y and Z of the pallet.

- **DistanceOfParts** (distance between parts)

  DistanceOfParts (three values) describes the distance between parts in directions X, Y and Z. DistanceOfParts could be a negative value, a negative value indicates that the part is placed in the negative direction of corresponding axis.

  The following figure describes the meaning of DistanceOfParts:

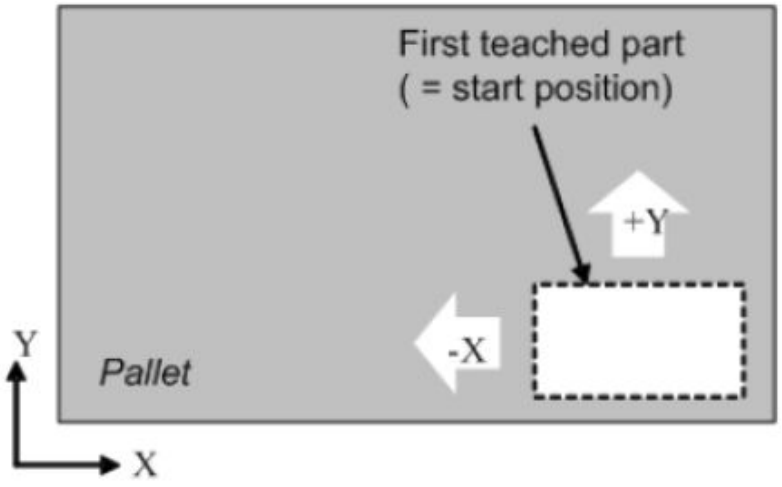


Figure 1 Distance between parts

- **PalletOrder** (palletizing order)

  PalletOrder is the order in directions X, Y and Z during the palletizing process, it has six values: X_Y_Z, X_Z_Y, Y_X_Z, Y_Z_X, Z_X_Y, Z_Y_X. X_Y_Z means that the robot at first performs the palletizing in direction X, then the palletizing in direction Y, finally the palletizing in direction Z. The following schematic shows a palletizing process:

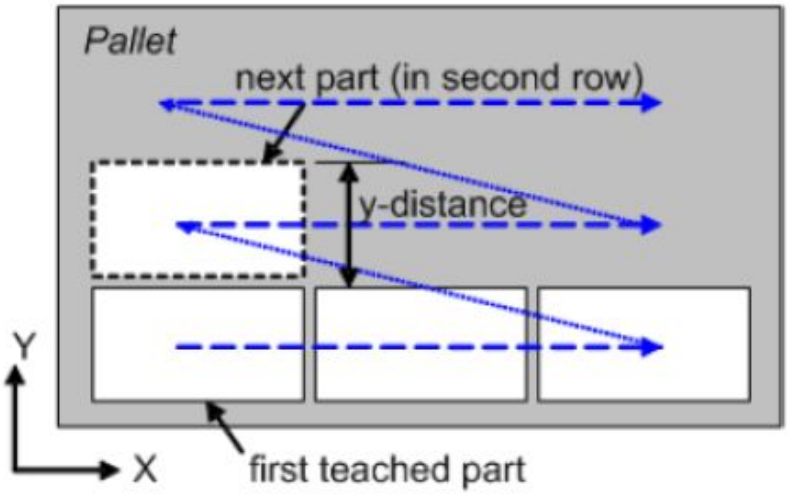


Figure 2 Palletizing process

- **FirstPartOnPalletPos** (first point of palletizing)

  FirstPartOnPalletPos describes the first point in palletizing, which could be taught in the palletizing variables (the reference coordinate system of this point is PalRefSys). The following schematic shows FirstPartOnPalletPos:

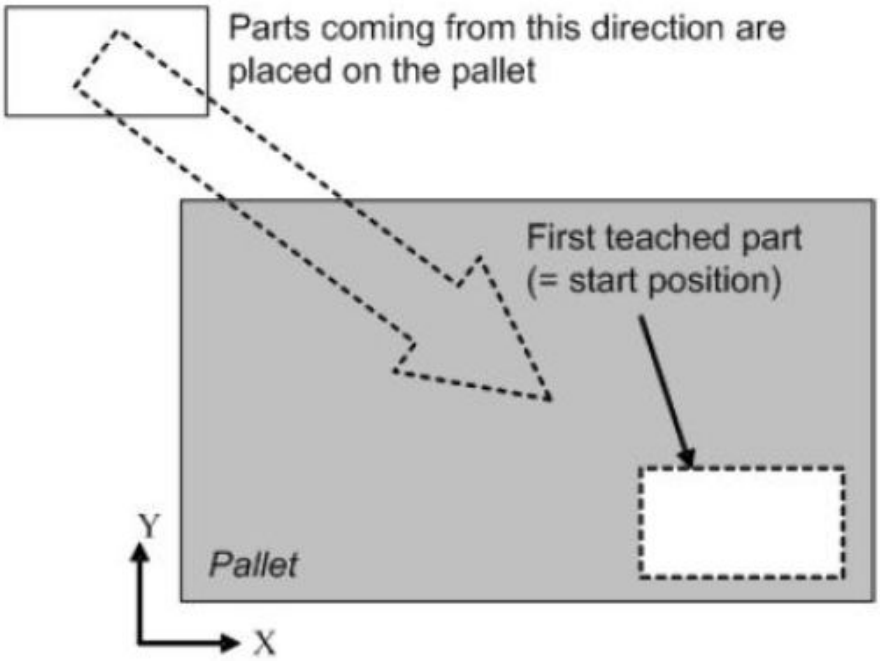


Figure 3 First point of palletizing

- **PalletEntryPointUsed** (if entry point is used)

  PalletEntryPointUsed describes that if the entry point is used during the palletizing process, if so, the robot must move to the entry point at first, then perform other movement. If entry point is used, the value of PalletEntryPointUsed is TRUE, otherwise the value of PalletEntryPointUsed is FALSE.

- **PalletEntryPoint** (entry point of palletizing)

  PalletEntryPoint describes the entry point in palletizing, which could be taught in the palletizing variables (the reference coordinate system of this point is PalRefSys). The following schematic shows PalletEntryPoint:

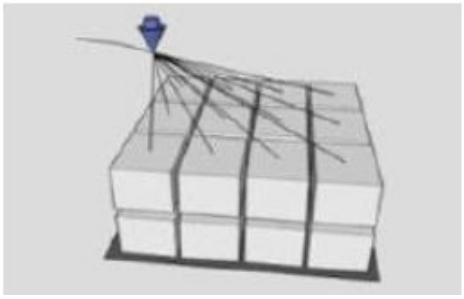


Figure 4 Entry point

- **PrePos** (pre-place position information of palletizing)

  The pre-place position could be used to prevent collision during the robot is performing palletizing, it includes three pieces of information: prePointIsInUse (judgment of whether entry point is used), preHeight (height of entry point), proSideOffset (side offset of entry point). The following schematic shows the pre-place position:

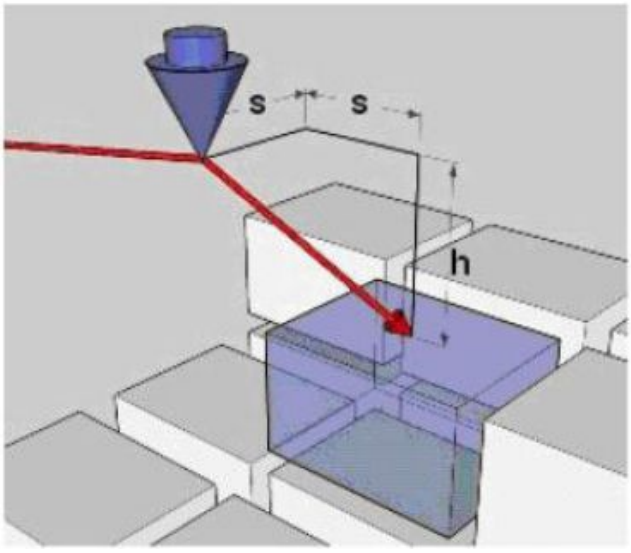


Figure 5 Pre-place position

- **PostPos** (post-place position information of palletizing)

  The post-place position describes a point which should be passed during the return process of palletizing. It includes three pieces of information: postPointIsInUse

(judgment of whether entry point is used), postHeight (height of entry point), postSideOffset (side offset of entry point).

3.3 Screen configuration of palletizing variables

Press the left side of the teach pendant  , then click PALLET in the pop-up tab to enter the configuration screen of palletizing variables.

1. The first screen

Select the palletizing variables to be configured, and set each input parameter in the screen.

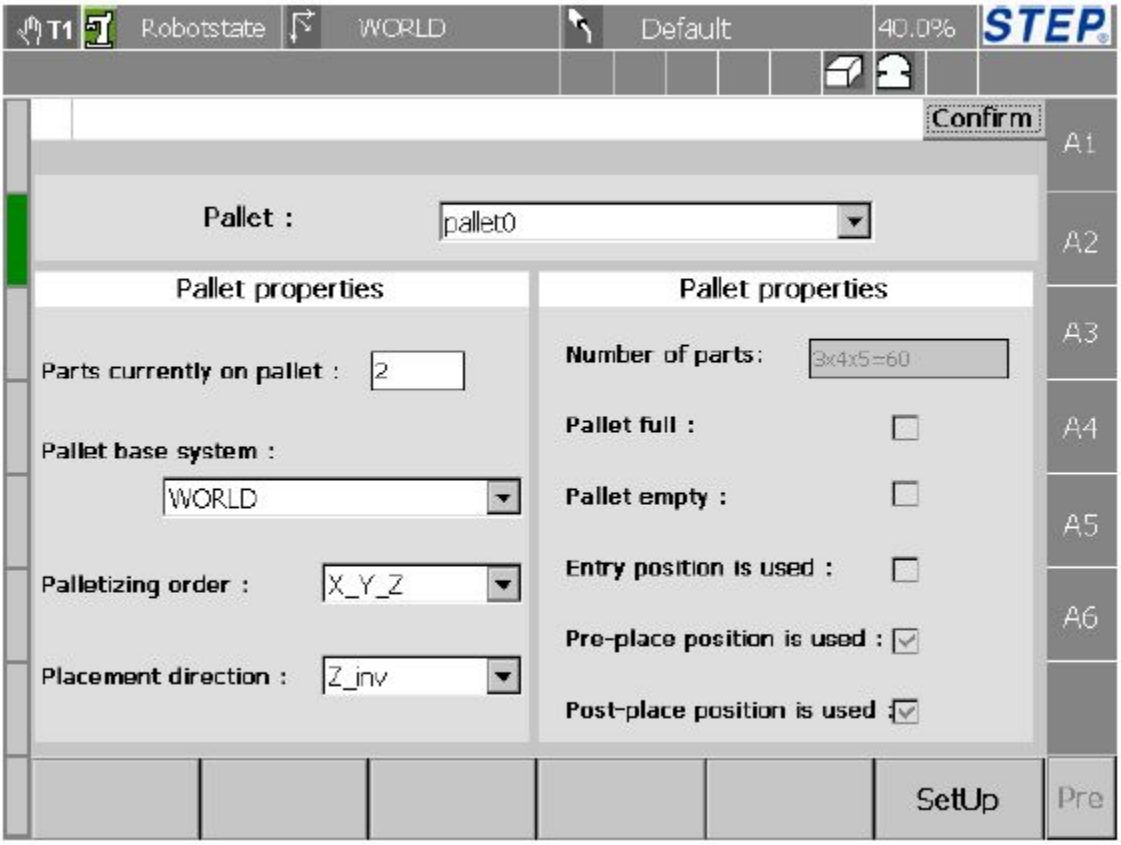


Figure 8 The first screen of palletizing variables teach (preview screen)

The input options provided in this screen include: actual number of parts, reference coordinate system, palletizing order, placement direction.

The view options provided in this screen include: total number of parts, marks of empty pallet and full pallet, if entry point is used, if pre-place position and post-place position are used.

Click SetUp to enter the teach screen of the first point of palletizing variables.

2. The second screen (teach screen of the first point)

The following figure shows the teach screen of the first point of palletizing variables:

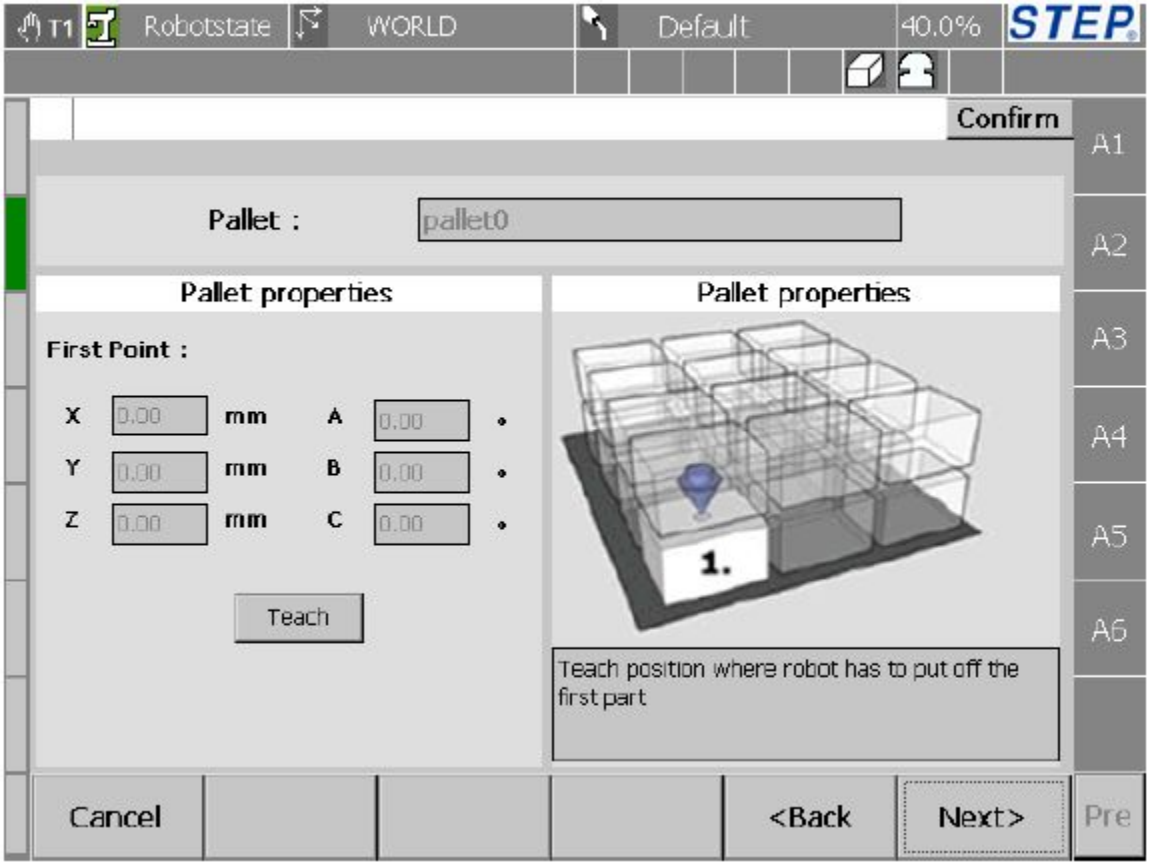


Figure 9 Teach screen of the first point of palletizing variables

Move the robot to the first point of palletizing, and keep the correct posture, click Teach button to complete the teach of the first point of palletizing.

Click Cancel to cancel the teach of palletizing variables, click Back button to return the previous screen, click Next to enter the information setting screen of parts to be palletized.

3. The third screen (information screen of parts to be palletized)

The following schematic shows the information setting of parts to be palletized:

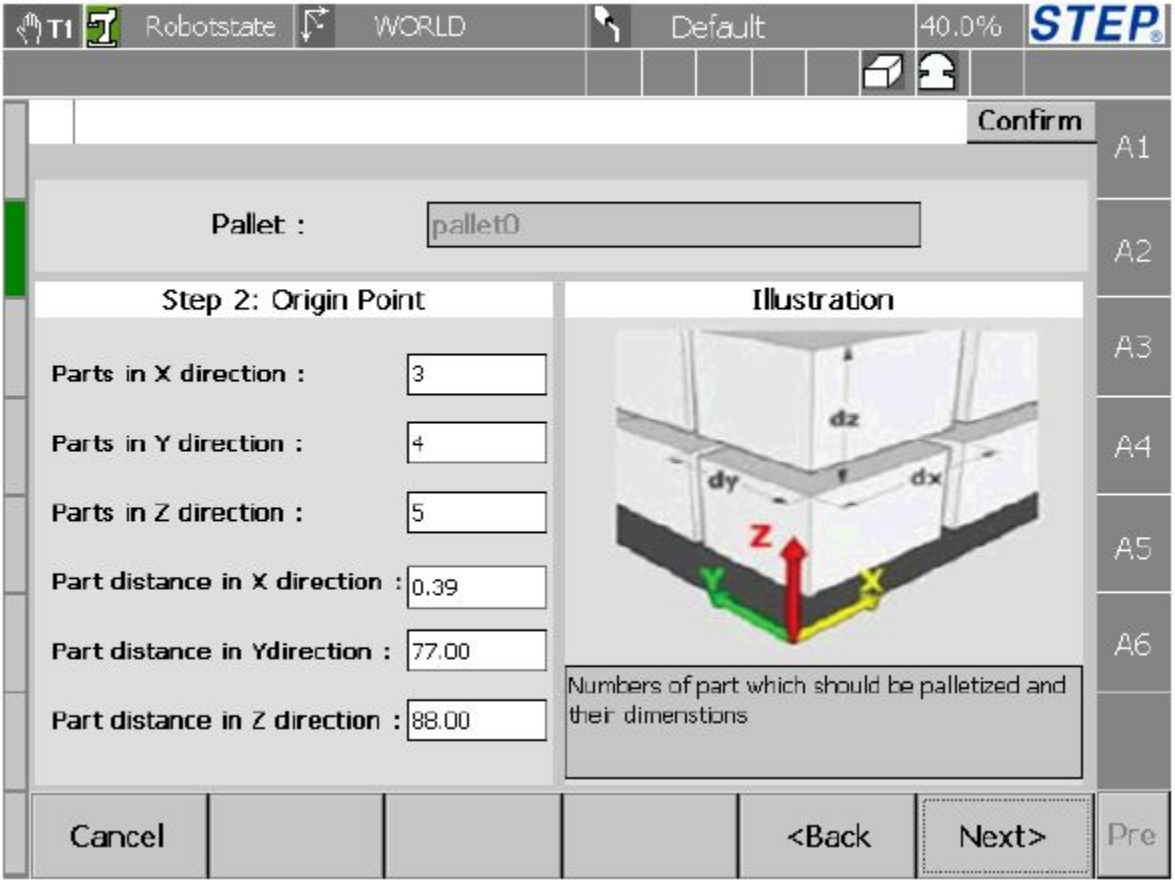


Figure 10 Information setting schematic of parts to be palletized

The input options provided in this screen include: number of parts in directions X, Y and Z, distance between parts in directions X, Y and Z, the default unit is MM.

Click Cancel to cancel the teach of palletizing variables, click Back button to return the previous screen, click Next to enter the setting screen of pre-place position and post-place position.

4. Setting screen of pre-place position and post-place position

The following figure shows the setting screen of pre-place position and post-place position:

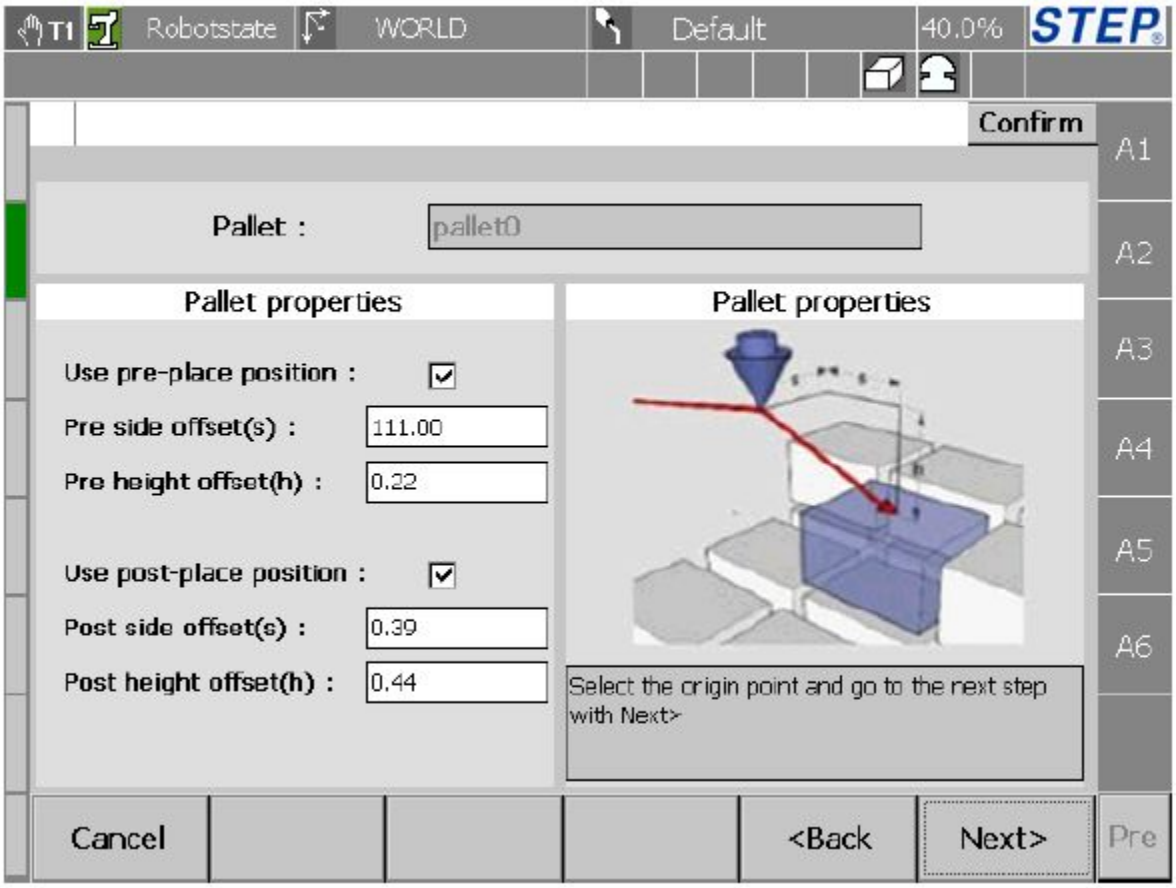


Figure 11 Setting screen of pre-place position and post-place position

The input options provided in this screen include: if pre-place position is used, Side offset information of pre-place position, Pre offset information of pre-place position, if post-place position is used, Side offset information of post-place position, Pre offset information of post-place position.

Click Cancel to cancel the teach of palletizing variables, click Back button to return the previous screen, click Next to enter the setting screen of pre-place position and post-place position.

Note: S and H of the pre-place position and post-place position are relative to the placement direction of palletizing. For example, if the placement direction is set to corresponding direction relative to directions X, Y and Z respectively, the H will vary with the setting of placement direction.

5. Teach screen of entry point

The following figure shows the teach screen of entry point of palletizing variables:

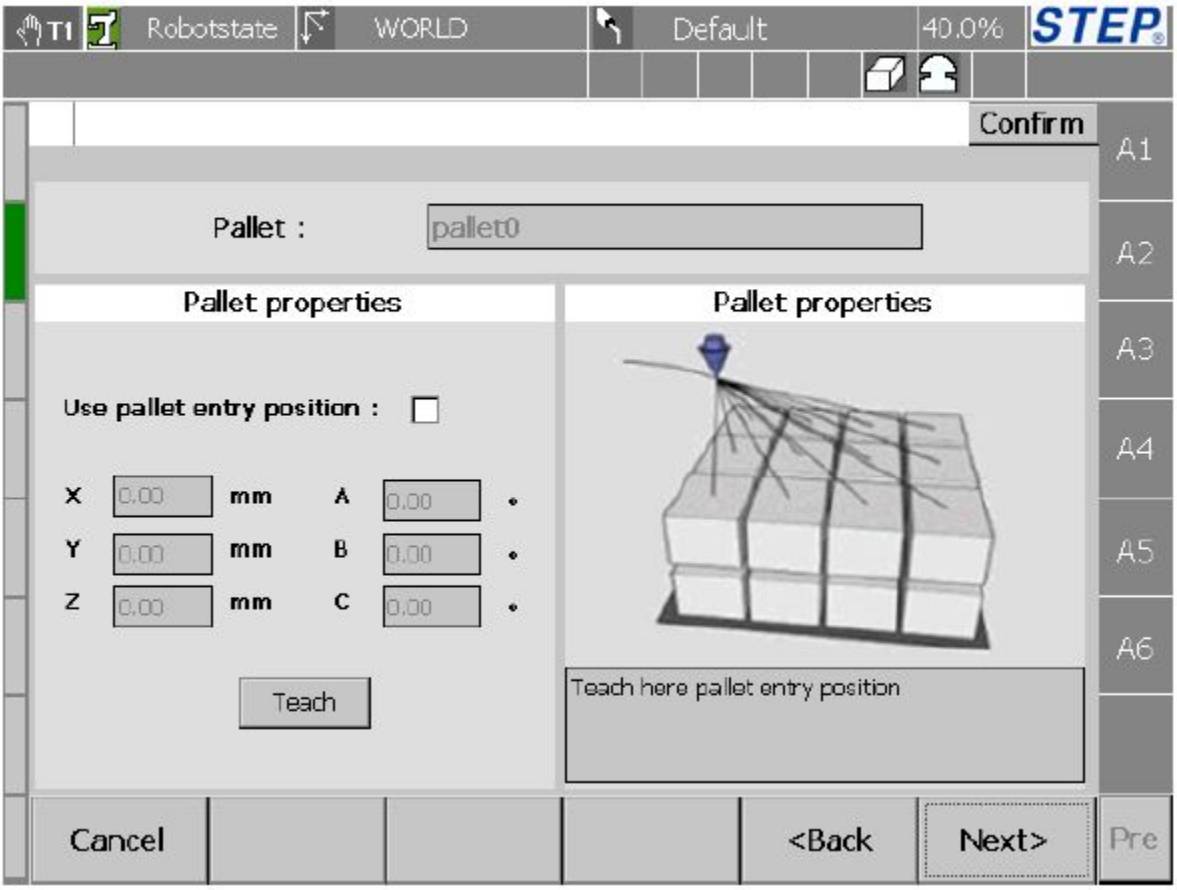


Figure 12 Teach screen of entry point of palletizing variables

Move the robot to the expected palletizing entry point, click Teach button to complete the teach of palletizing entry point.

The input provided in this screen includes: if entry point is used.

Click Cancel to cancel the teach of palletizing variables, click Back button to return the previous screen, click Next to enter the test screen of palletizing variables.

6. Test screen of palletizing variables

The following figure is the test screen of palletizing variables:

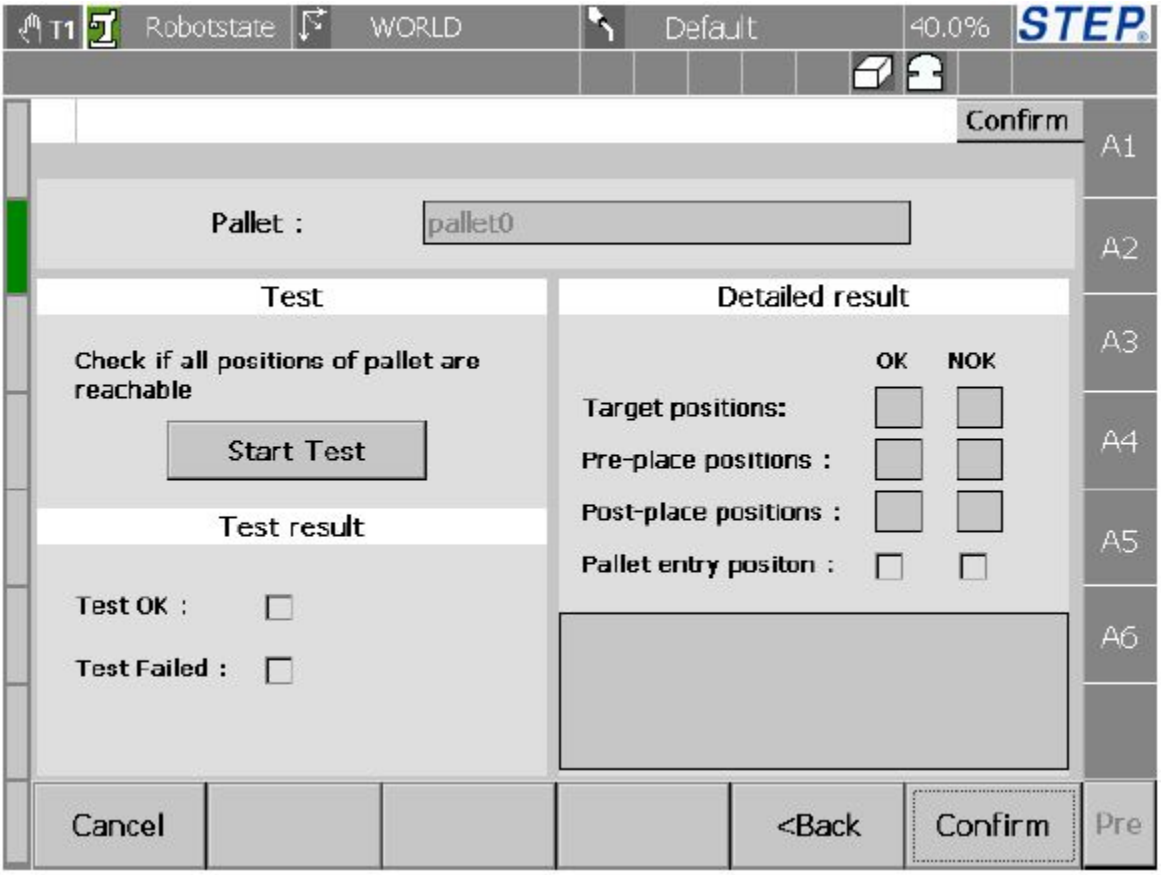


Figure 13 Test screen of palletizing variables

Click Start Test button to complete the test of palletizing variables, the test result will be displayed in this screen. Test result column will display the overall test result, and Detailed result will display the detailed information of the test result.

Click Cancel to cancel the teach of palletizing variables, click Back button to return the previous screen, click Next to enter the setting screen of pre-place position and post-place position.

Chapter IV Palletizing statement

4.1 New creation of statement

The palletizing function provides five related statements, as shown below.

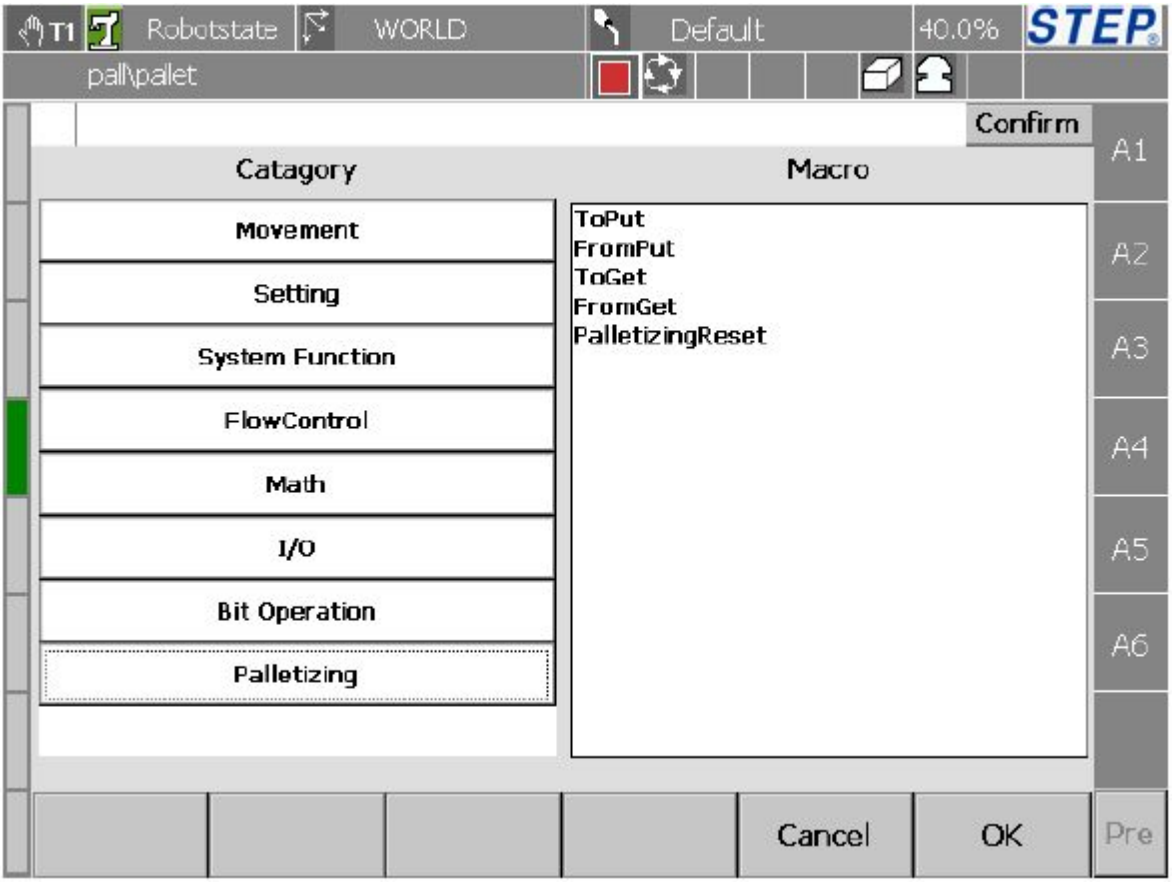


Figure 14 New creation of palletizing statement

4.2 Description of statement

4.2.1 ToPut statement

ToPut statement is used for palletizing, which will be expanded to a series of Lin movement statements, finally to the target point.

The example of ToPut statement is as shown below, the three parameter types in this statement are: palletizing variable, dynamic parameter, smoothing parameter.

```
ToPut ( param1, parma2, parma3 )
```

The following schematic shows the ToPut movement process:

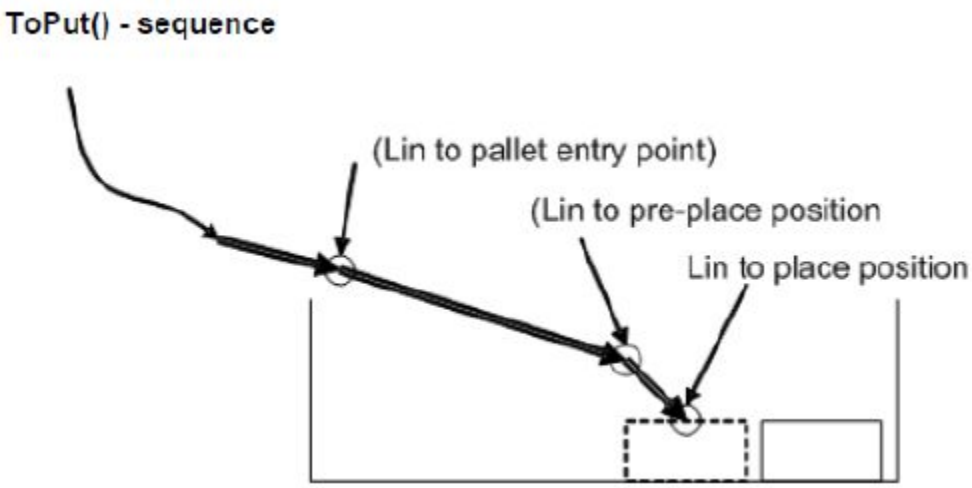


Figure 15 ToPut statement schematic

ToPut statement movement process is described as follows:

- Move along straight line (Lin) to the entry point (optional)
- Move along straight line (Lin) to the pre-place position (optional)
- Move along straight line (Lin) to the target point (required)

4.2.2 FromPut statement

FromPut statement is used for palletizing, which will be expanded to a series of Lin movement statements, finally to the target point.

The example of FromPut statement is as shown below, the four parameter types in this statement are: palletizing variable, dynamic parameter, smoothing parameter, if palletizing is finished.

```
FromPut ( param1, parma2, parma3,parma4 )
```

The following schematic shows the FromPut movement process:

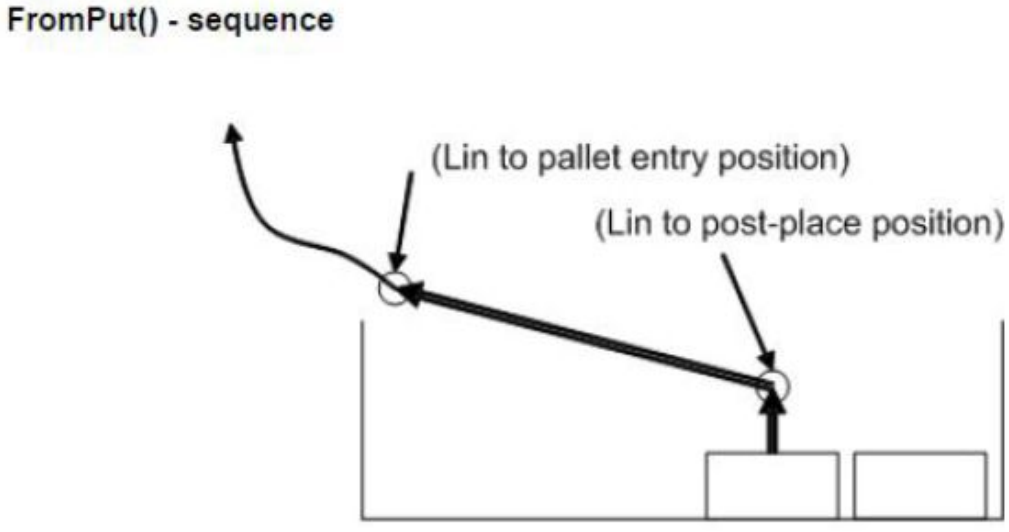


Figure 16 FromPut statement schematic

FromPut statement movement process is described as follows:

- Move along straight line (Lin) to the post-place position (optional)
- Move along straight line (Lin) to the entry point (optional)

4.2.3 ToGet statement

ToGet statement is used for palletizing, which will be expanded to a series of Lin movement statements, finally to the target point.

The example of ToGet statement is as shown below, the three parameter types in this statement are: palletizing variable, dynamic parameter, smoothing parameter.

```
ToGet ( param1, parma2, parma3 )
```

The following schematic shows the ToGet movement process:

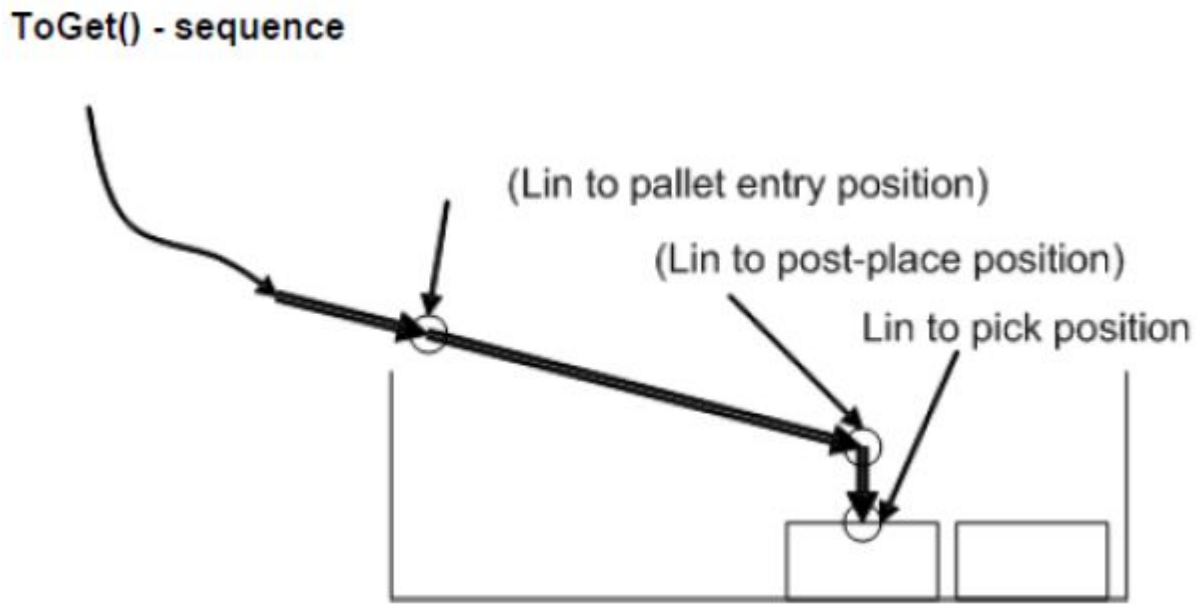


Figure 17 ToGet statement schematic

ToGet statement movement process is described as follows:

- Move along straight line (Lin) to the entry point (optional)
- Move along straight line (Lin) to the pre-place position (optional)
- Move along straight line (Lin) to the target point (required)

4.2.4 FromGet statement

FromGet statement is used for palletizing, which will be expanded to a series of Lin movement statements, finally to the target point.

The example of FromGet statement is as shown below: FromGet (param1, parma2, parma3, parma4). The four parameter types in this statement are: palletizing variable, dynamic parameter, smoothing parameter, if depalletizing is finished.

The following schematic shows the FromGet movement process:

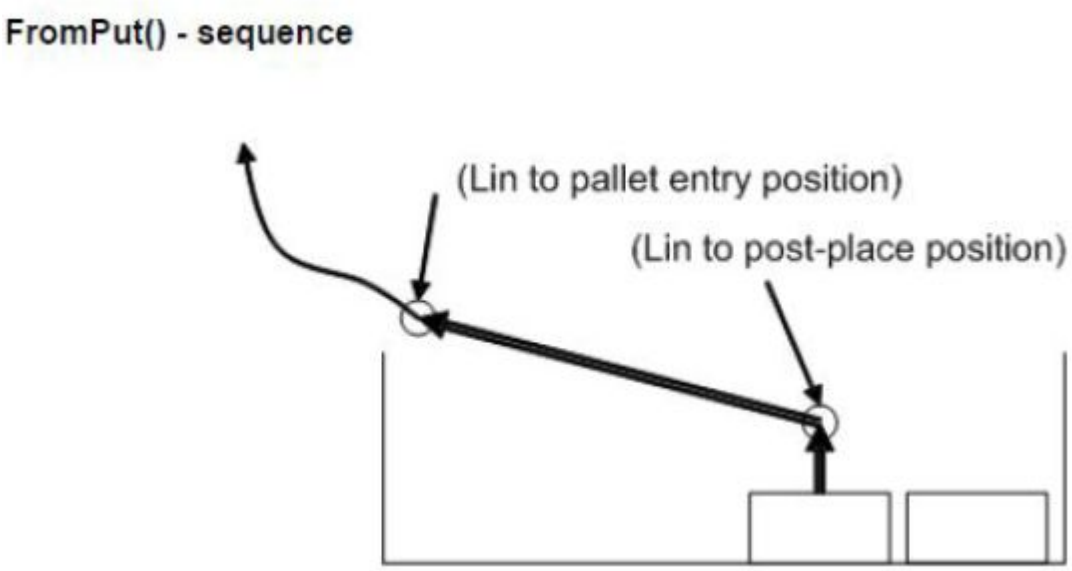


Figure 18 FromPut statement schematic

FromGet statement movement process is described as follows:

- Move along straight line (Lin) to the post-place position (optional)
- Move along straight line (Lin) to the entry point (optional)

4.2.5 PalletizingReset statement

PalletizingReset statement is used to reset the "actual number of parts" parameter in the palletizing variables.

The example of PalletizingReset statement is as shown below, the two parameter types in this statement are: palletizing variable, number of parts (UNIT type).

```
PalletizingReset ( param1, parma2 )
```

Note: Both of the configuration screen and palletizingreset statement could be used to reset the number of parts on the pallet, but the priority level of PalletizingReset statement is higher.

Chapter V Palletizing example

5.1 Palletizing example of single pallet

The using of palletizing function mainly includes two parts: screen configuration of palletizing variables and programming of palletizing statements.

The following is the demonstration of a palletizing function:

5.1.1 New creation of palletizing variable

Enter the variables screen, and newly create a palletizing variable pallet0 under global.

5.1.2 Configuration and related point teach of palletizing variable

Enter the palletizing configuration screen through the teach pendant key, according to the introduction in Section 3.3, set the palletizing direction parameter, first point, entry point, pre-place position, post-place position and other information in proper order as per the actual using conditions. Especially notice the difference between palletizing direction and placement direction.

Note: The placement direction is related to the settings of pre-place position and post-place position.

5.1.3 Programming

Write palletizing program at the teach pendant client:

```
//****Palletizing method, for single pallet****
WHILE(bool0)DO
ToPut(pallet);
WaitTime(uint0);
FromPut(pallet,NULL,NULL,bool0);
END_WHILE
//Once an article is palletized, bool0 is used to judge if the pallet is full, if the pallet is full, the value of bool0 is false;
//Palletize articles on the pallet cyclically, until the value of bool0 is False.

//****Depalletizing method, for single pallet****
WHILE(bool0)DO
ToGet(pallet);
WaitTime(uint0);
FromGet(pallet,NULL,NULL,bool0);
END_WHILE
//Once an article is removed, bool0 is used to judge if the pallet is empty, if the pallet is empty, the value of bool0 is False
//Remove articles from the pallet cyclically, until the value of bool0 is false
```

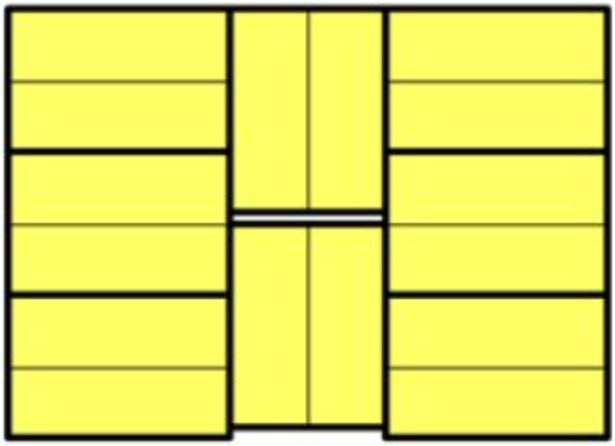
5.1.4 Run the robot

After the program is compiled, load and run the above-mentioned two program segments respectively, then the robot will be seen performing the palletizing or depalletizing function according to the specified placement number, placement order and placement direction.

Note: If LOOP is used as the cycle condition, the number variable used in LOOP couldn't be automatically restored to the initial value after the loop is finished, which could only be restored after EOF is executed after the program is run completely. If it's necessary to enter LOOP before the last statement, then an assignment statement for the number variable should be added. During palletizing, if the judging condition in the loop is the last bool variable of fromget or fromput, then after palletizing is completed, the value of this bool variable is changed to false. If after the program is run completely and before EOF is executed, it's necessary to enter the palletizing loop, then an assignment statement should be added manually and change the bool variable to true.

5.2 Palletizing example of several pallets

5.2.1 Project requirements



Project requirements:

At first place 3 parts transversely, then place 2 parts longitudinally, then place 3 parts transversely. Then execute the above mentioned process again.

According to the example picture sent (top view), herein 2 programming methods are given:

5.2.2 Method 1

Use two loops, determine the number of parts to be palletized with the parameters set in loop, the program is as follows:

```
    uint_WaiCeng:=2;//2 times are required for completing the whole process, it's necessary to set the outermost layer to 2
    LOOP(uint_WaiCeng)DO
    PalletizingRest(pallet,uint7);
```

```
PalletizingReset(pallet1,uint8);
PalletizingReset(pallet0,uint9);//Set the original workpiece number of each pallet to 0
Uint10:=3;//According to the requirement, 3 pieces shall be put horizontally for the first time, then the value is 3.
LOOP(uint10)DO
ToPut(pallet);
FromPut(pallet,NULL,NULL,bool3);
END_LOOP //The first operation loop of the first pallet ends
uint7:=uint7+3;//Record the number of the articles that have been put, which will be used in the PalletReset statement of the second loop.
uint11:=2;//According to the requirement, 2 pieces shall be put vertically, then the value is 2.
LOOP(uint11)DO
ToPut(pallet1);
FromPut(pallet1,NULL,NULL,bool4);
END_LOOP
uint8:=uint8+2;//Record the number of the articles that have been put
uint12:=3;//According to the requirement, 3 pieces shall be put horizontally, then the value is 3
LOOP(uint12)DO
ToPut(pallet0);
FromPut(pallet0,NULL,NULL,bool5);
END_LOOP
uint9:=uint9+3;//Record the number of the articles that have been put
END_LOOP //The loop ends, return to the line of LOOP, and start the next loop.
```

5.2.3 Method 2

Judge if the pallet is full with bool_isFull variable, the program is as follows:

```
WHILE(bool_isFull_0)DO
//The last parameter of the FromPut statement is used to indicate whether the loop ends. The original value of this bool variable is TRUE, while the palletizing is finished, it will be set to FALSE automatically, and jump out of the loop.
PalletizingReset(pallet,uint7);
PalletizingReset(pallet1,uint8);
PalletizingReset(pallet0,uint9);//Set the original workpiece number of each pallet to 0.
uint10:=3;//According to the requirement, 3 pieces shall be put horizontally, then the value is 3
LOOP(uint10)DO
ToPut(pallet);
FromPut(pallet,NULL,NULL,bool_isFull_0);
END_LOOP
uint7:=uint7+3;//Record to the number of the articles that have been put
uint11:=2;//According to the requirement, 2 pieces shall be put vertically, then the value is 2
LOOP(uint11)DO
ToPut(pallet1);
FromPut(pallet1,NULL,NULL,bool_isFull_1);
END_LOOP
uint8:=uint8+2;//Record the number of the articles that have been put
uint12:=3;//According to the requirement, 3 pieces shall be put horizontally, then the value is 3
LOOP(uint12)DO
ToPut(pallet0);
FromPut(pallet0,NULL,NULL,bool_isFull_2);
END_LOOP
uint9:=uint9+3;//Record the number of the articles that have been put
END_WHILE//When bool_isFull is 1, the loop ends
```

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- ✧ Type and serial number of the control system
- ✧ Version number of the control system
- ✧ Additional software package (optional)
- ✧ Current application program
- ✧ Additional accessories (such as positioner and rail, optional)
- ✧ Problem description, fault duration and frequency etc.

◆ **Contact**

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