



智流形机器人
从 制 造 到 智 造

INSTRUCTION

Robot Control System

Palletizing Process Documentation

Copyright Statement

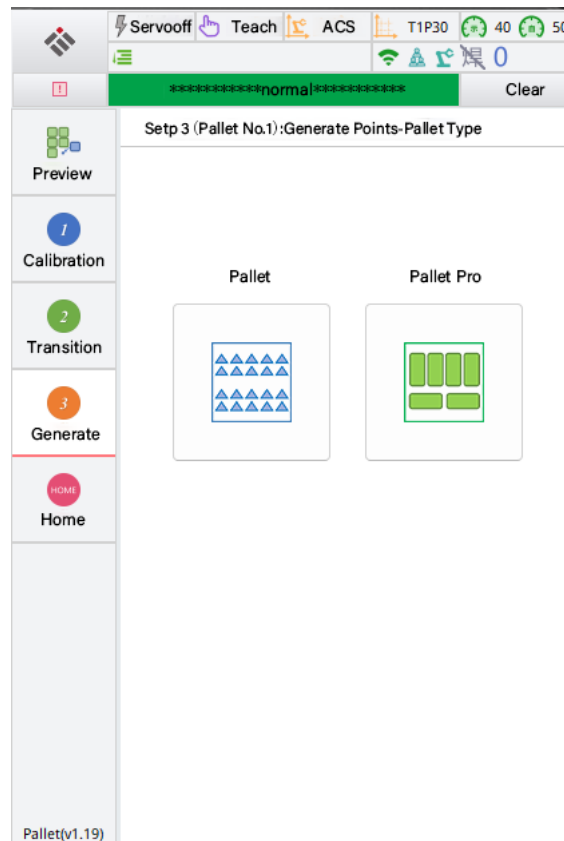
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1 Palletizing Process Description

Palletizing process involves stacking workpieces in a certain order based on teaching of representative points. Palletizing function can be divided into simple palletizing and advanced palletizing based on the way points are generated, and a quick setup interface is provided.



Simple Palletizing: Used for regular arrangement applications, calculates stack point positions based on teaching row-column direction and distance.

Advanced Palletizing: Users arrange virtual blocks on the interface (set position and placement angle), and transform them to the actual workpiece coordinate system.

1.1 Simple Palletizing Basic Information Setting

This section mainly introduces the basic information of each button and display interface. For detailed operation steps, please refer to Chapter 2.

1.1.1 Stack Point Viewing Interface

The screenshot displays the 'Stack Point Viewing Interface' with a sidebar on the left containing icons for Preview, Calibration, Transition, Generate, and Home. The main area is titled 'Setp 3 (Pallet No.1):Generate Paints-Pallet Pro'. It contains several sections: 1. Tray size (Length: 1, width: 1), 2. Workpiece size (Length: 1, width: 1, height: 1), 3. Pallet reference point (X: 13.1300, Y: 8.8800, Z: -0.2800, Roll: 179.9142, Pitch: 3.0611, Yaw: 165.6138), 4. Pallet template settings (Total number of floors: 1, All layers are the same: 12, First layer: Not used, Height compensation: 0, View Template), and 5. Pallet(v1.19) status. Red boxes and numbers 1 through 16 are overlaid on the interface to highlight specific elements.

Section	Parameter	Value
1. Tray size	Length	1
	width	1
	height	1
2. Workpiece size	Length	1
	width	1
	height	1
3. Pallet reference point	X	13.1300
	Y	8.8800
	Z	-0.2800
	Roll	179.9142
	Pitch	3.0611
	Yaw	165.6138
4. Pallet template settings	Total number of floors	1
	All layers are the same	12
	First layer	Not used
	Height compensation	0

1. Palletizing Process Number: Serial number of stack/pile, palletizing process supports up to 10 stacks/piles.

2. Stack Point Generation Status: When stack point is generated, it will be displayed in green.

3. Point ID: Serial number ID of generated stack point.

4. Current Position: Displays the position information of the robot in the current user coordinate system.

5. Stack Point Offset Value X.

6. Stack Point Offset Value Y.

7. Stack Point Offset Value Z.

8. Stack Point Offset Value A.

9. Stack Point Offset Value B.

10. Stack Point Offset Value C.

11. Compare Current Position: Displays position comparison information of the robot's current position point.

12. Modify All: Can independently set and modify the number.

13. Set Interval Count: Can independently set and modify the interval count.

14. Modify Current: Modify the position information of the current point ID.
15. Modify to Specified Number: Modify the position information of the number specified in step 12.
16. Next Step: Start setting the next page.
17. Save Changes: Save settings after completion.
18. Clear Stack Points: Clear all stack points of the current process number (can be used when modification of points is needed).
19. Move to Stack Point: In the up servo state, clicking this button, then clicking the forward button on the handheld box, the robot will move in a straight line to the current stack point position.

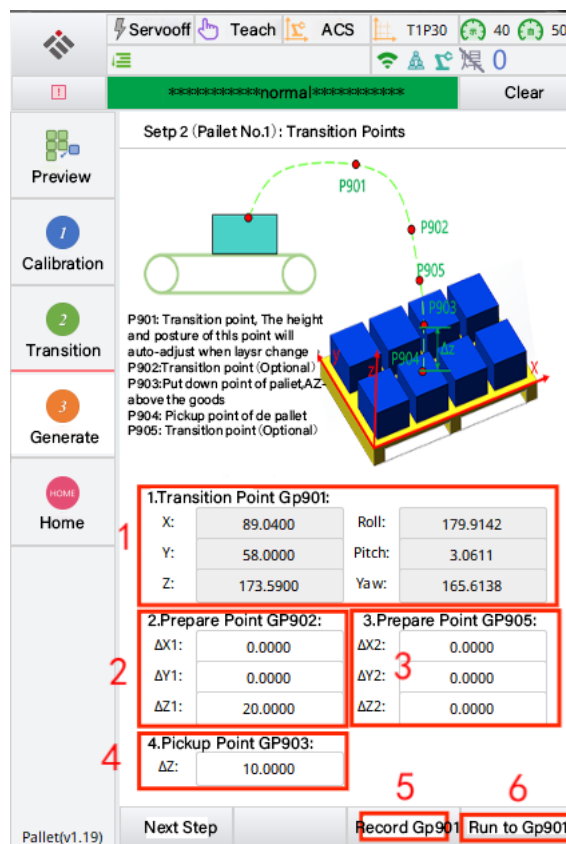
1.1.2 Tray Calibration Interface



1. PCS Number: Position to establish tray coordinate system, supports up to 32 positions.
2. Note: Notes need to be made under the coordinate system management interface.
3. Tray Coordinate System: Display interface of calculated coordinate system after completion.

4. Record P1: P1 point of tray coordinate system.
5. Record P2: P2 point of tray coordinate system.
6. Record P3: P3 point of tray coordinate system.
7. Move to Point P1: Move the robot to point P1 position.
8. Move to Point P2: Move the robot to point P2 position.
9. Move to Point P3: Move the robot to point P3 position.
10. Set as Current: Apply the current tray coordinate system after calculation.
11. Calculate: Calculate the tray coordinate system after calibration record.

1.1.3 Transition Point Setting Interface



1. Transition Point GP901: Optional transition point, which will automatically adjust height with the actual number of layers of goods, and the posture of this point will also be automatically adjusted to the actual posture of the goods.

2. Ready Point GP902: The second pause point between the entry point and the point above the workpiece (optional).

3. Ready Point GP905: The third pause point between the entry point and the point above the workpiece (optional).

4. Delivery Point GP903: Height distance from goods ΔZ , delivery position during palletizing.

5. Record GP901: Record the position information of the current robot as transition point GP901.

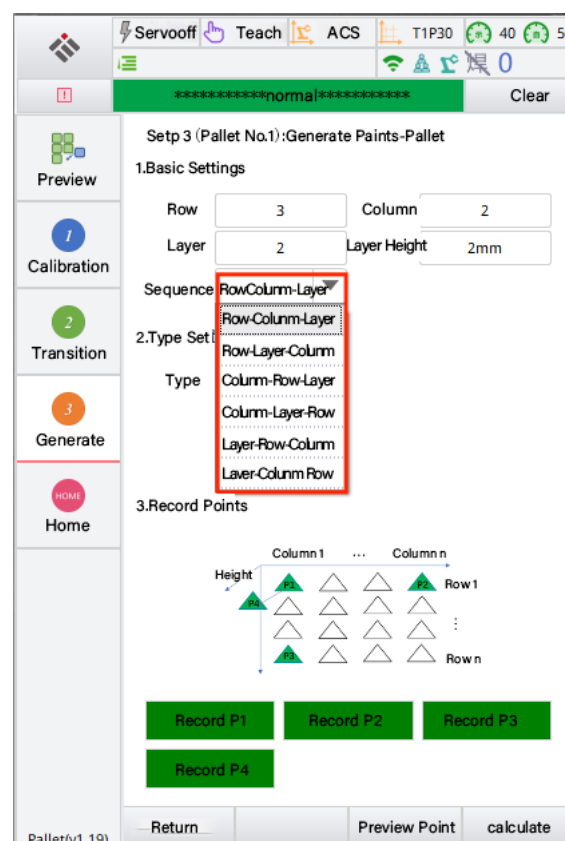
6. Move to GP901: In the up servo state, clicking this button, then clicking the forward button on the handheld box, the robot will move in a straight line to GP901 position.

1.1.4 Simple Palletizing Stack Point Generation Interface

1. Number of Rows: Set the total number of rows for palletizing.
2. Number of Columns: Set the total number of columns for palletizing.
3. Number of Layers: Set the total number of layers for palletizing.
4. Single Layer Height: Set the height of a single layer for palletizing.
5. Palletizing Sequence: Set the sequence of stacking direction during palletizing process (e.g., Row Column Layer: stack rows first, then columns, and finally layers).
6. Stack Shape Setting: Set the stack shape (e.g., Regular Palletizing: workpiece shape and stacking direction are consistent, with the same row spacing).
7. Record P1: Record the position of the first row and column of the first layer.

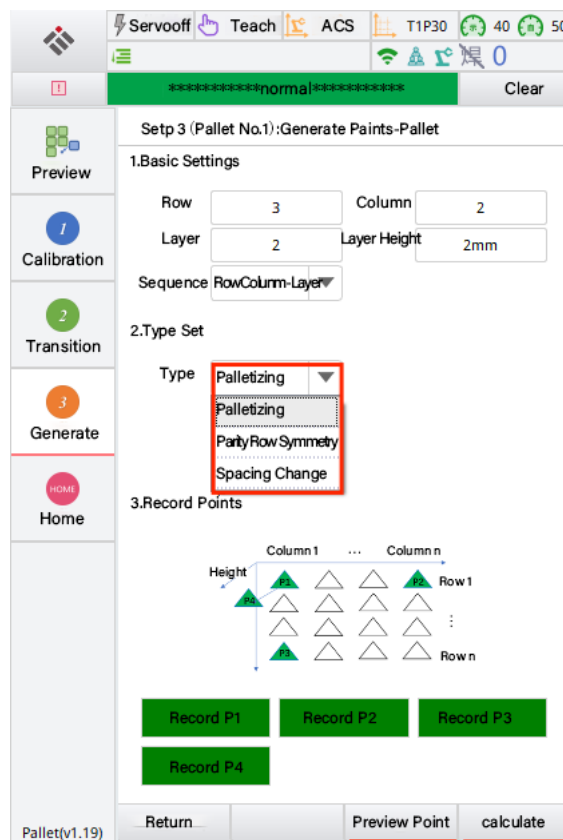
8. Record P2: Record the position of the last column of the first row of the first layer.
9. Record P3: Record the position of the last row of the first column of the first layer.
10. Record P4: Indicates the height direction of the stack point.
11. Return Type Selection: Return to the previous page to select simple palletizing or advanced palletizing functions.
12. Teaching Points: Independent interface to move the robot to recorded position points.
13. Calculate: Click to calculate and generate stack points after setting stack shape.

1.1.4.1 Explanation of Palletizing Sequence Options



As shown in the figure.

1.1.4.2 Explanation of Stack Types



1. Regular Palletizing: Workpiece shapes and stacking directions are consistent, with the same row spacing.

P1: Position of first row first column of first layer

P2: Position of last column of first row of first layer

P3: Position of last row of first column of first layer

P4: Indicates the height direction of the stack point

2. Even-Odd Row Symmetry

P1: Position of first row first column of first layer

P2: Position of last column of first row of first layer

P3: Position of last row of first column of first layer

P4: Indicates the height direction of the stack point

P5: Pose of the first item in even rows, used to calibrate the distance between odd and even rows and the posture of all even rows. The difference in placement direction between even and odd rows is determined by this point.

3. Spacing Variation

P1: Position of first row first column of first layer

P2: Position of last column of first row of first layer

P3: Position of last row of first column of first layer

P4: Indicates the height direction of the stack point

P5: A point is set at the position of the first layer and first row, and the angle of this point and the initial row and the distance between the rows are used to calibrate the positions and angles of each row.

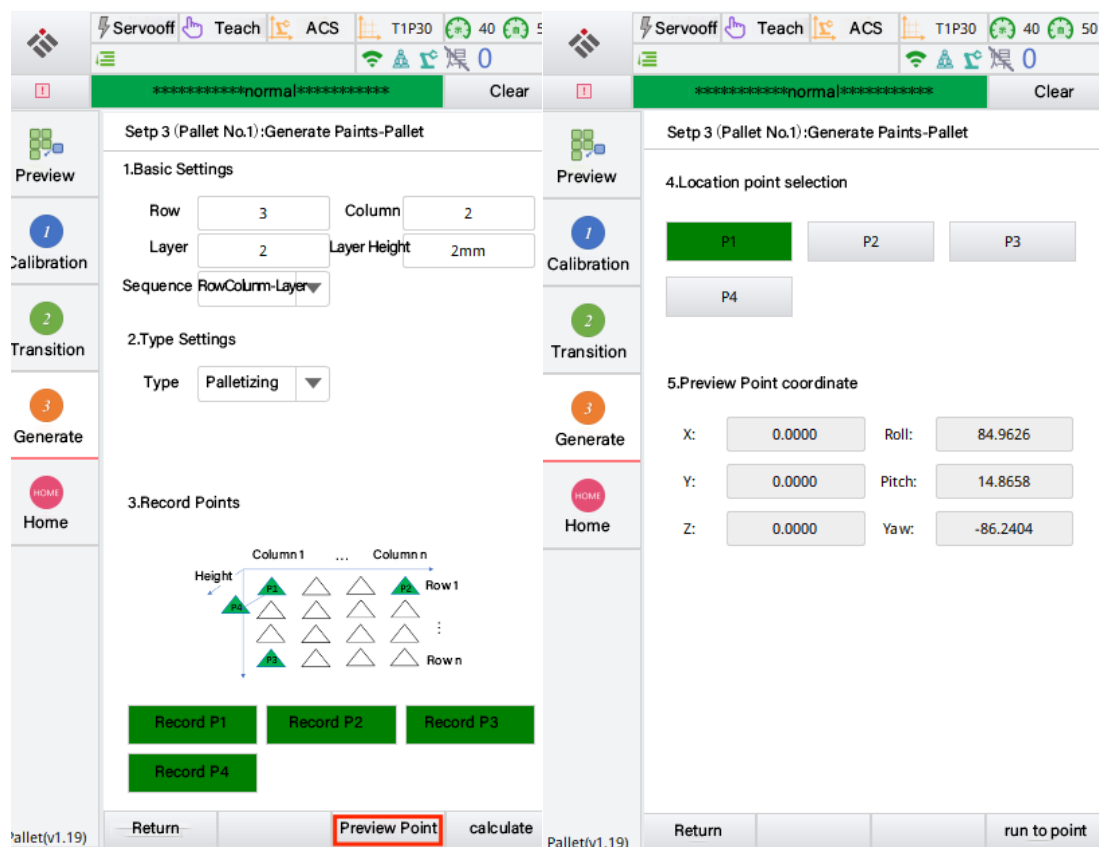
P6: Next position where the row spacing changes, used to calculate the distance after the change in row spacing

Number of rows transformed: Currently only supports 1 or 2

Transformed row 1: Row number where the first row spacing changes

Transformed row 2: Row number where the second row spacing changes

1.1.4.3 Teaching Point Description



Teaching point function can return to historical taught positions.

1.Click on "Teaching Point".

2.Select the position ID.

3.Click "run to Point", the robot servo is activated, click the "Forward" button on the pendant box, and the robot will move to that point.

1.2 Setting Basic Information for Advanced Palletizing

Setting basic information for advanced palletizing is basically the same as setting basic information for simple palletizing. The only difference lies in the stack point generation interface. Advanced palletizing supports customized stack points, offering greater flexibility compared to simple palletizing.

1.2.1 Generating Stack Points in Advanced Palletizing

The screenshot shows the 'Generate Paints-Pallet Pro' interface. The left sidebar contains buttons for 'Preview', 'Calibration', 'Transition', 'Generate', and 'Home'. The main area is titled 'Setp 3 (Pallet No.1):Generate Paints-Pallet Pro'. It contains several sections with input fields and buttons, numbered 1 through 16:

- 1. Tray size: Long along tray coordinate system X direction, wide along Y direction (mm). Fields for 'Length' (1) and 'width' (1).
- 2. Workpiece size: length along the X direction of the pallet coordinate system, width along the Y direction (mm). Fields for 'Length' (1) and 'width' (1).
- 3. Workpiece height: height (mm). Field for 'height' (1).
- 4. Pallet reference point P_b (The first cargo position on the first floor). Fields for X: 13.1300, Y: 8.8800, Z: -0.2800, Roll: 179.9142, Pitch: 3.0611, Yaw: 165.6138.
- 5. Pallet template settings. Fields for 'Total number of floors' (1), 'All layers are the same' (12), 'First layer' (10), 'Not used' (11), 'Height compensation: 0' (11), and 'View Template' (12).
- 6. Buttons at the bottom: 'return' (13), 'record' (14), 'run to' (15), and 'calculate' (16).

1. Tray Length: Actual measured length of the tray, along the X-direction of the tray coordinate system.

2. Tray Width: Actual measured width of the tray, along the Y-direction of the tray coordinate system.

3. Workpiece Length: Actual measured length of the workpiece, along the X-direction of the tray coordinate system.

4. Workpiece Width: Actual measured width of the workpiece, along the Y-direction of the tray coordinate system.

5. Workpiece Height: Actual measured height of the workpiece.

6. Palletizing Reference Point: The first position point of the first item held by the robot for palletizing.

-
7. Clear Settings: Clear palletizing template and height compensation.
 8. Total Layers: Set the number of layers required for palletizing.
 9. Template Arrangement Type: Set different arrangement types for different layers of palletizing.
 - 9.1 All Layers Identical: All layers use the same template; only need to set the template for the first layer.
 - 9.2 Even-Odd Layer Y-Swap: Templates for even layers are symmetrically swapped with templates for odd layers along the Y-axis.
 - 9.3 Even-Odd Layer X-Swap: Templates for even layers are symmetrically swapped with templates for odd layers along the X-axis.
 - 9.4 Custom: Use up to 5 different templates simultaneously.
 10. Layer Templates: Set different templates for different layers (supports up to ten templates).
 11. Height Compensation: Height value for compensation of layers using this template, with the standard height being the workpiece height.
 12. View Templates: Independent interface for setting different templates.
 13. Return Type Selection: Return to the previous page to select either simple or advanced palletizing functions.
 14. Record (P_b): Record the palletizing reference point.
 15. Move to (P_b): Move to the recorded palletizing reference point.
 16. Calculate: Click to calculate and generate stack points after setting the palletizing shape.

1.2.2 Interface for Template Settings in Advanced Palletizing

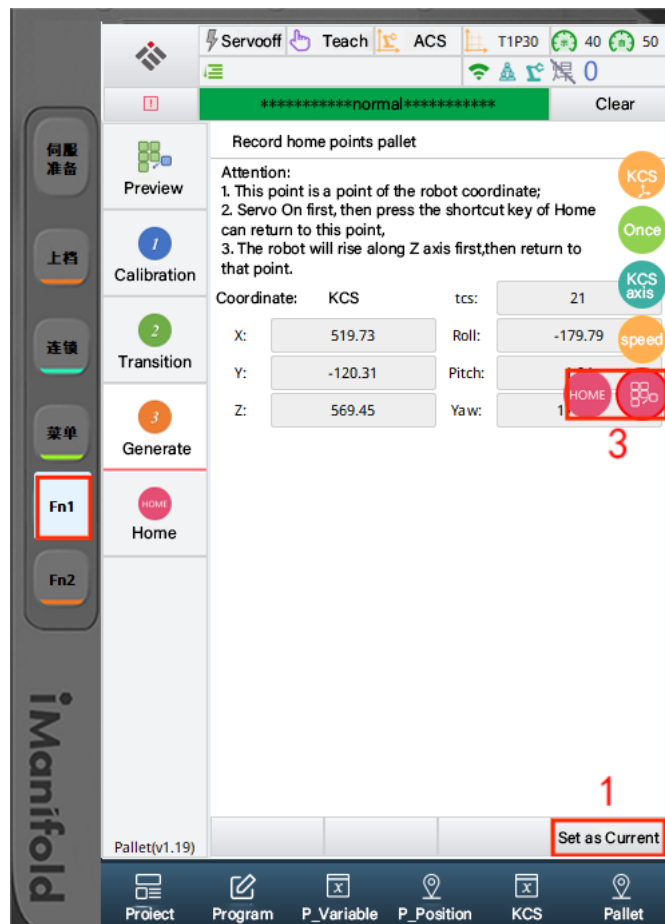


1. Template Number: Indicates the current template and the number of workpieces.
2. Copy: Copies the entire template.
3. Paste: Pastes the entire template.
4. Decrease Workpiece: Removes the last workpiece.
5. Increase Workpiece: Adds a workpiece.
6. Tray: Displays the tray size and the positions of the workpieces (tray dimensions need to be input beforehand).
7. Workpiece: Displays the coordinates of the center point of the generated workpieces (workpiece dimensions need to be input beforehand).
8. Current Workpiece: Selects a workpiece; clicking on the tray directly selects the workpiece.
9. Angle: Rotates the selected workpiece.
10. X Coordinate: Sets the X coordinate of the selected workpiece.
11. Y Coordinate: Sets the Y coordinate of the selected workpiece.

-
12. Distance: Sets the distance the workpiece will move (workpiece cannot be moved by pressing keys if distance is not set).
 13. Left: Moves the workpiece to the left by the specified distance.
 14. Right: Moves the workpiece to the right by the specified distance.
 15. Up: Moves the workpiece up by the specified distance.
 16. Down: Moves the workpiece down by the specified distance.
 17. Up-Down Toggle: Allows the moving workpiece to switch positions up and down relative to the previous workpiece.
 18. Left-Right Toggle: Allows the moving workpiece to switch positions left and right relative to the previous workpiece.
 19. Return to Settings: Returns to the main interface of advanced palletizing.
 20. Clear: Clears the entire template.
 21. Reset: Resets to the state saved last time.
 22. Save: Saves the template.

1.3 Interface for Palletizing Home Position Setting

This interface is for setting the palletizing home position, facilitating quick return to position in case of abnormal situations during production. It's important to note that this point is in the robot coordinate system, where the robot first ascends along the Z-axis before returning to this point.



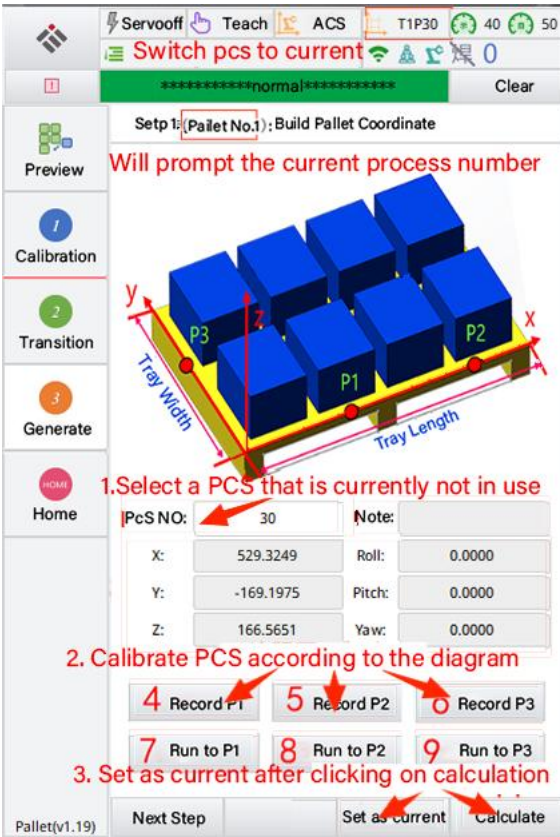
1. Select a safe position and click to set it as the current palletizing home position.
2. Press the "Fn1" button on the pendant box to bring up the shortcut menu.
3. Click the "Palletizing Zero" button. In the state of servo-on, long press the "HOME" button. The robot will first ascend along the Z-axis before returning to this point.

2 Palletizing Operation Process

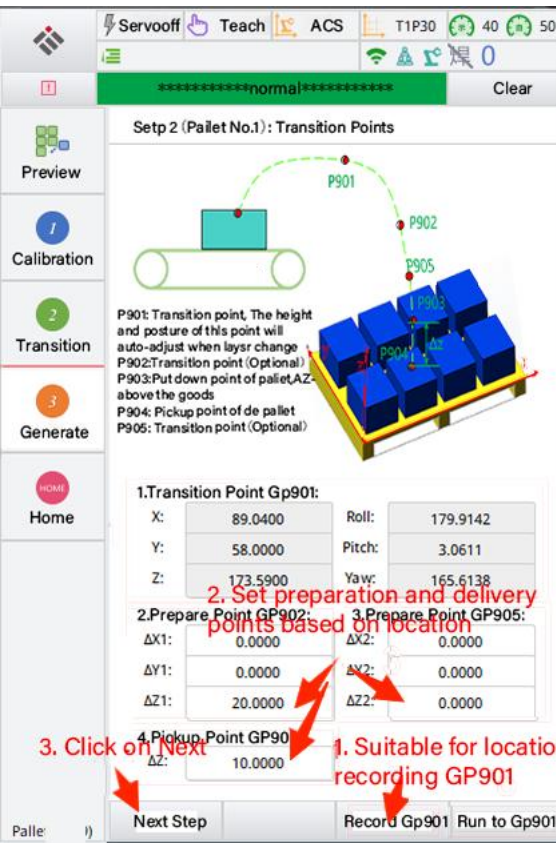
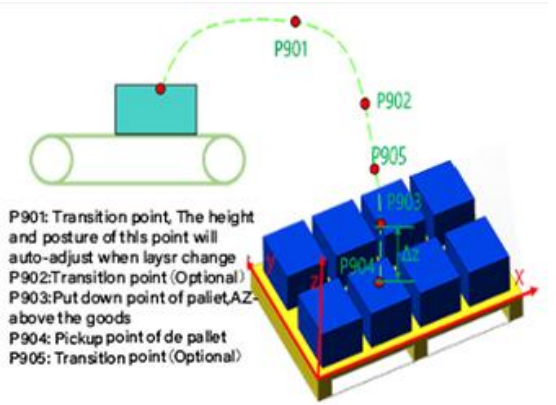
2.1 Viewing Stack Points

Operation Steps	diagram
1. Click on "Stacking Point View". 2. Select an unused stacking process number: The stacking function can save up to 10 sets of stacking points. (Note: If stacking points have been generated and this configuration has been used, click on "Clear Stacking Points" before configuring a new one. You can also directly modify the stacking points and then save). 3. After selecting the required stacking process number, click on "Next Step" or click on "Tray Calibration" on the left to proceed to the next step.	The screenshot shows the 'Preview Pallet Points' window. On the left sidebar, the 'Preview' button is highlighted. The main window has a title bar 'Preview Pallet Points' and a 'Pallet No.' field set to '1/10'. Below this, there are fields for 'Point No.' (0) and various coordinate fields (Type, tcs, X, Y, Z, ΔX, ΔY, ΔZ, ΔRoll, ΔPitch, ΔYaw). At the bottom, there are buttons for 'Next Step', 'Save', 'clear point', and 'run to point'. Red arrows point to the 'Preview' button, the 'Pallet No.' field, and the 'Next Step' button. Text labels 'click preview', 'SelectPallet No', and 'Click Next' are placed near the arrows.

2.2 Tray Calibration

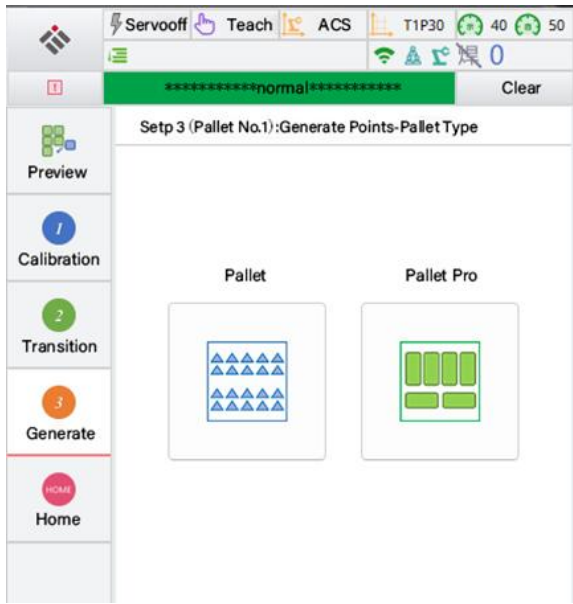
Operation Steps	diagram
1. Select an unused PCS number: There are a total of 32 sets available for selection. 2. Refer to the image to teach and calibrate the tray coordinates for positions P1, P2, and P3. (Supports moving to the teaching position points for easy viewing and modification). 3. Click on "Calculate". After successful calculation, click on "Set as Current". Once set as current, the PCS number displayed on the status bar above the interface will change to the currently calibrated PCS number. 4. Click on "Next Step" to proceed to the transition point settings.	 Will prompt the current process number 1. Select a PCS that is currently not in use 2. Calibrate PCS according to the diagram 3. Set as current after clicking on calculation

2.3 Transition Point Settings

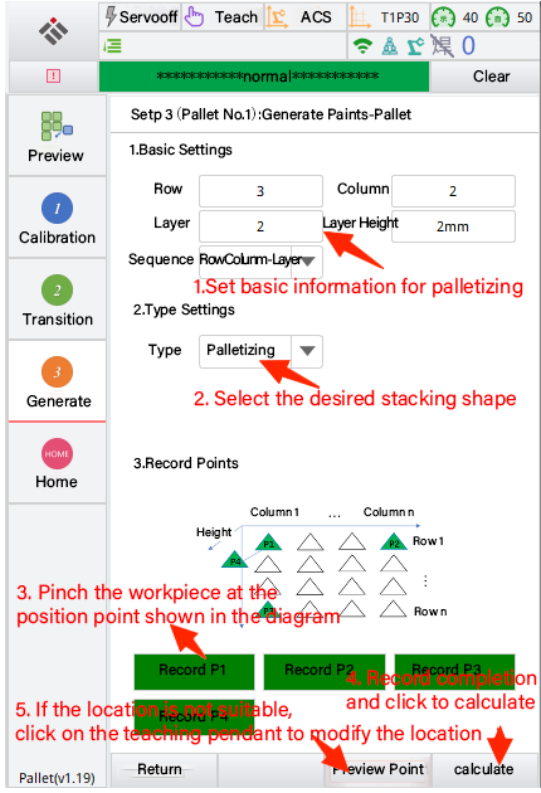
Operation Steps	diagram
1. Teach the robot to a suitable transition point, then click on "Record GP901". The recorded position will be displayed in the transition point GP901 item on the interface. 2. Refer to the diagram to set up the preparation point GP902, GP905, and the unloading point GP903. 3. Click on "Next Step" or click on "Stacking Point Generation" on the left to proceed to the next step, entering the stacking point generation phase.	
Transition Point Explanation: - GP901: In actual movement, the height of GP901 will automatically increase or decrease with the increase or decrease in the number of layers of the stacking point. - GP902 and GP905: These points are offset positions based on GP904, with the same orientation as GP904. (Note: Preparation points cannot have orientation settings. If orientation is required, GP902 and GP905 do not need to be set, and orientation transitions need to be directly added in the program.)	

- GP903: This is an offset unloading point based on the generated stacking point. - GP904: This represents the actual stacking point position and is generally used as the pickup point.	
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2.4 Stacking Point Generation

Operation Steps	diagram
There are two options available for stacking: "Simple Stacking" and "Advanced Stacking". Click on the respective button to enter the corresponding settings interface.	 The screenshot shows the 'Setp 3 (Pallet No.1):Generate Points-Pallet Type' interface. The interface is divided into a sidebar on the left and a main content area on the right. The sidebar contains buttons for 'Preview', 'Calibration', 'Transition', 'Generate', and 'Home'. The main content area displays two options: 'Pallet' and 'Pallet Pro'. The 'Pallet' option shows a grid of blue triangles, and the 'Pallet Pro' option shows a grid of green rectangles. The interface also includes a top bar with various icons and a 'Clear' button.

2.4.1 Simple Palletizing

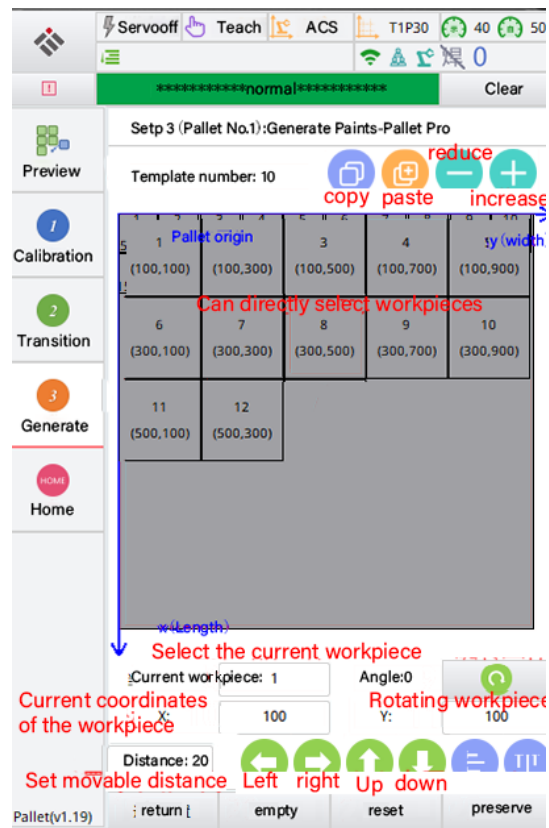
Operation Steps	diagram
1. Basic Information for Setting Palletizing Points: Palletizing Sequence, Example Selection of Rows and Columns, Layers. 2. Palletizing Type: Example Selection of Ordinary Palletizing. 3. Recording Position Points: P1: Position of the first row, first column, and first layer. P2: Position of the last column in the first row of the first layer. P3: Position of the last row in the first column of the first layer. P4: Representation of the stacking point in the vertical direction.	 The screenshot shows the 'Setp 3 (Pallet No.1):Generate Paints-Pallet' interface. The left sidebar contains buttons for 'Preview', 'Calibration', 'Transition', 'Generate', and 'Home'. The main area is divided into sections: '1.Basic Settings', '2.Type Settings', and '3.Record Points'. Red arrows and text provide instructions: '1.Set basic information for palletizing' points to the 'Row', 'Column', 'Layer', and 'Layer Height' fields; '2. Select the desired stacking shape' points to the 'Type' dropdown menu; '3. Pinch the workpiece at the position point shown in the diagram' points to the 'Record P1' button; '4. Record completion and click to calculate' points to the 'calculate' button; and '5. If the location is not suitable, click on the teaching pendant to modify the location' points to the 'Preview Point' button. The 'Record Points' section displays a grid of points for recording.

4. Click to calculate. If successful, it will automatically return to the palletizing point viewing interface, indicating that the palletizing points have been generated.

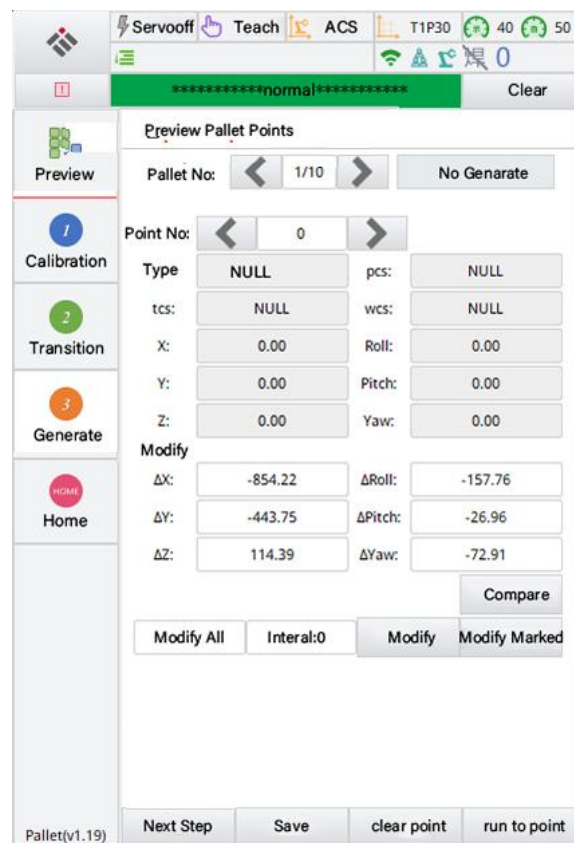
2.4.2 Advanced Palletizing

Operation Steps	diagram
1. Set pallet dimensions. 2. Set workpiece dimensions. 3. Move the gripper to the position of the first item on the first layer and click "Record (P_b)". 4. Set the total number of layers: for example, choose 1 layer, and select all layers to be the same. 5. Choose template 1 for the first layer. 6. Click "View Template" to set the placement positions.	

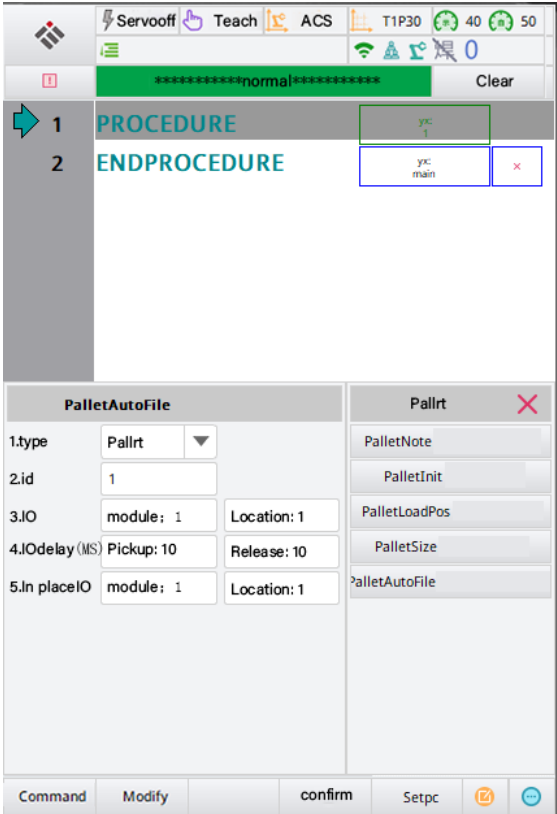
1. Click "Add" or "Subtract" to adjust the number of palletizing points.
2. Click "Copy" and "Paste" to duplicate the same workpiece.
3. Click "Rotate" to change the orientation of the palletizing template.
4. Set the movable distance, then click "Up," "Down," "Left," or "Right" to move the palletizing point accordingly.
5. Click "Switch Left/Right" or "Switch Up/Down" to move the palletizing point to the adjacent position.
6. Click "Save."
7. Click "Back to Settings" to return to the palletizing setup interface.



8. Click "Calculate." If successful, it will automatically return to the palletizing point viewing interface, indicating that the palletizing points have been generated.



2.5 Writing Instructional Documents

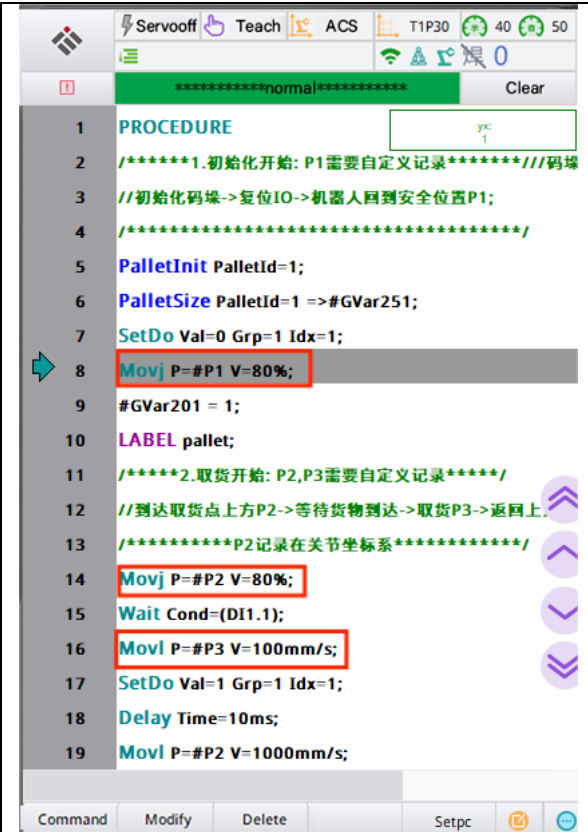
Operation Steps	diagram
Enter the program editing interface 1. Click on "Command Overview". 2. Click on "Palletizing". 3. Click on "PalletAutoFile".	 The screenshot shows the robot programming interface. At the top, there is a status bar with various icons and values. Below it, a menu titled 'Command Overview' is displayed. The 'Pallrt' option is highlighted with a red box and a red number 2. The 'PalletAutoFile' option is highlighted with a red box and a red number 3. The 'Command' button at the bottom is also highlighted with a red box and a red number 1.
4. Set parameters: For example, Palletizing Type: Palletizing; Tool IO: 1; Process Number: 1; IO Delay: 10; Goods In Place IO: 1; 5. Click "Confirm Insert" to insert the command.	 The screenshot shows the 'PalletAutoFile' dialog box. The 'Pallrt' option is selected in the '1.type' dropdown. The '2.id' field is set to 1. The '3.IO' field is set to 'module: 1' and 'Location: 1'. The '4.IODelay (MS)' field is set to 'Pickup: 10' and 'Release: 10'. The '5.In place IO' field is set to 'module: 1' and 'Location: 1'. The 'confirm' button at the bottom is highlighted with a red box.

6. Record actual positions for P1, P2, P3:

P1: Robot safe position.

P2: Above the conveyor belt.

P3: Pickup position from the conveyor belt



```

1  PROCEDURE
2  /*****1.初始化开始: P1需要自定义记录*****/
3  //初始化码垛->复位IO->机器人回到安全位置P1;
4  /*****
5  PalletInit PalletId=1;
6  PalletSize PalletId=1 =>#GVar251;
7  SetDo Val=0 Grp=1 Idx=1;
8  Movj P=#P1 V=80%;
9  #GVar201 = 1;
10 LABEL pallet;
11 /*****2.取货开始: P2,P3需要自定义记录*****/
12 //到达取货点上方P2->等待货物到达->取货P3->返回上.
13 /*****P2记录在关节坐标系*****/
14 Movj P=#P2 V=80%;
15 Wait Cond=(DI1.1);
16 Movl P=#P3 V=100mm/s;
17 SetDo Val=1 Grp=1 Idx=1;
18 Delay Time=10ms;
19 Movl P=#P2 V=1000mm/s;

```

Note: When writing the palletizing execution program, this part needs to be tailored to the user's own requirements by embedding palletizing action instructions into the process program.

2.6 Palletizing Instruction Explanation

Instruction Name	Example and Parameter Explanation
PalletNote	//GP901 Transition Point //GP902 Transition Point($\Delta X, \Delta Y, \Delta Z$) //GP903 Unloading Point //GP904 Pick-up Point //GP905 Transition Point($\Delta X, \Delta Y, \Delta Z$);
PalletInit	PalletInit PalletId=2
PalletLoadPos	PalletLoadPos PalletId=1 GoodsId = #GVar201 =>#GP901 GoodsId: The current palletizing point index to be obtained After retrieving the position points, assign them to global positional variables starting from the index value (901-905) 。
PalletSize	PalletSize PalletId=1 =>#GVar251 Assign the retrieved number of palletizing points to the global numerical variable
PalletAutoFile	Generate palletizing program segment

example program

PROCEDURE

/*

*/

PalletInit PalletId=1;

PalletSize PalletId=1 =>#GVar251;

//get the total number of palletizing points and record the number to GVar251

SetDo Val=0 Grp=1 Idx=1;

Movj P=#P1 V=80%;

#GVar201 = 1;

// Reset the palletizing count variable Gvar201

LABEL pallet;

Movj P=#P2 V=80%;

//P2 is the position above the pick-up point

Wait Cond=(DI1.1);

Movl P=#P3 V=100mm/s;

// P3 is the position of the pick-up point

SetDo Val=1 Grp=1 Idx=1;

Delay Time=10ms;

Movl P=#P2 V=1000mm/s;

LABEL reset;

IF (#GVar201<=#GVar251) THEN;

// whether the current number of palletizes exceeds the total number

PalletLoadPos PalletId=1 GoodsId=#GVar201 =>#GP901;

Movj P=#GP901 V=80%;

Movl P=#GP902 V=1000mm/s Bl=10mm;

Movl P=#GP903 V=300mm/s Bl=10mm;

SetDo Val=0 Grp=1 Idx=1;

Delay Time=10ms;

Movl P=#GP902 V=800mm/s Bl=10mm;

Movj P=#GP901 V=70%;

#GVar201 = #GVar201+1;

JUMP pallet;

ELSE;

Pause;

#GVar201 = 1;

```
JUMP reset;  
ENDIF;  
ENDPROCEDURE
```