R12 Tool Changer instructions.

WARNING: PROGRAMMING AND SETTING UP THE R12 TOOL CHANGER SYSTEM IS NOT TRIVIAL.

Be prepared to crash the robot and restart a few times.
Please read the R12 manual and the getting started manual to gain experience before using the tool changers. The user should be familiar with projects and routes before starting. Leave a tool attached to the robot by hand until you have mastered accurate positioning.

Overview

The pneumatic devices comprise a pneumatic gripper, a vacuum pickup with 4 cups and a tool changer system. The robot can pick up either the vacuum pickup or the pneumatic gripper or an electric gripper (or any other device) with the tool changer. The tool not in use is parked on a rack.

Pneumatic gripper and vacuum pickup valve cicuit
THIS ITEM IS MOUNTED ON A BASE WITH TEMPORARY CONNECTIONS FOR TESTING ONLY
Re-house in your industrial cabinet if this is an industrial application.

The pneumatics circuit comprises 3 valves and a Venturi to produce vacuum. See diagram below. Connect to the robot base as indicated on the robot.

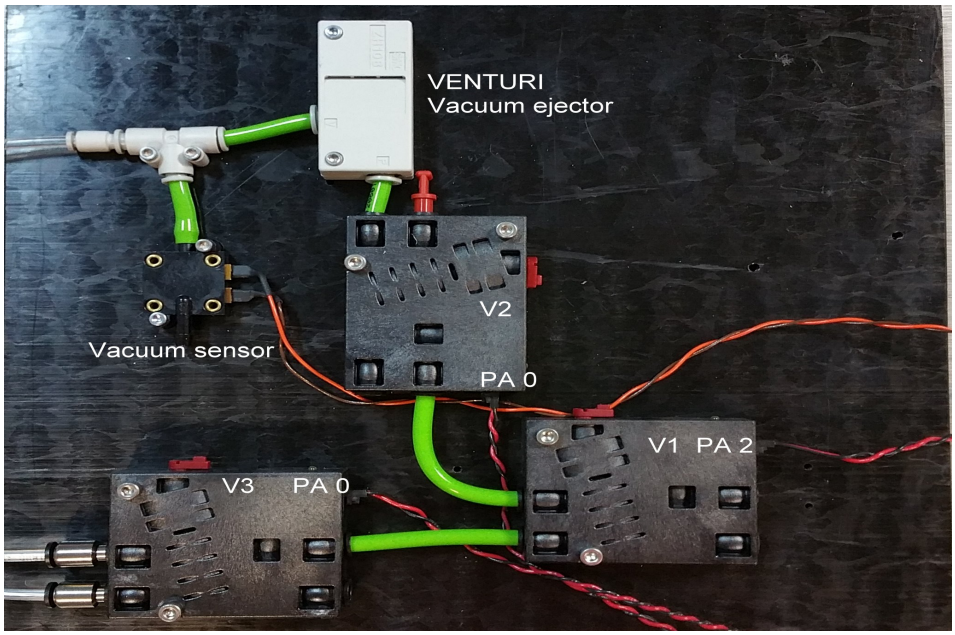


Diagram 1

Port 2 of valve V2 is blocked off. When all valves are off there is no air flow.
If there is no vacuum pickup then the Venturi and valve V2 will be missing and valve V1 will be blocked off at port 3. See diagram 3.

Pneumatic connections to the tool changer for both gripper and vacuum pickup.

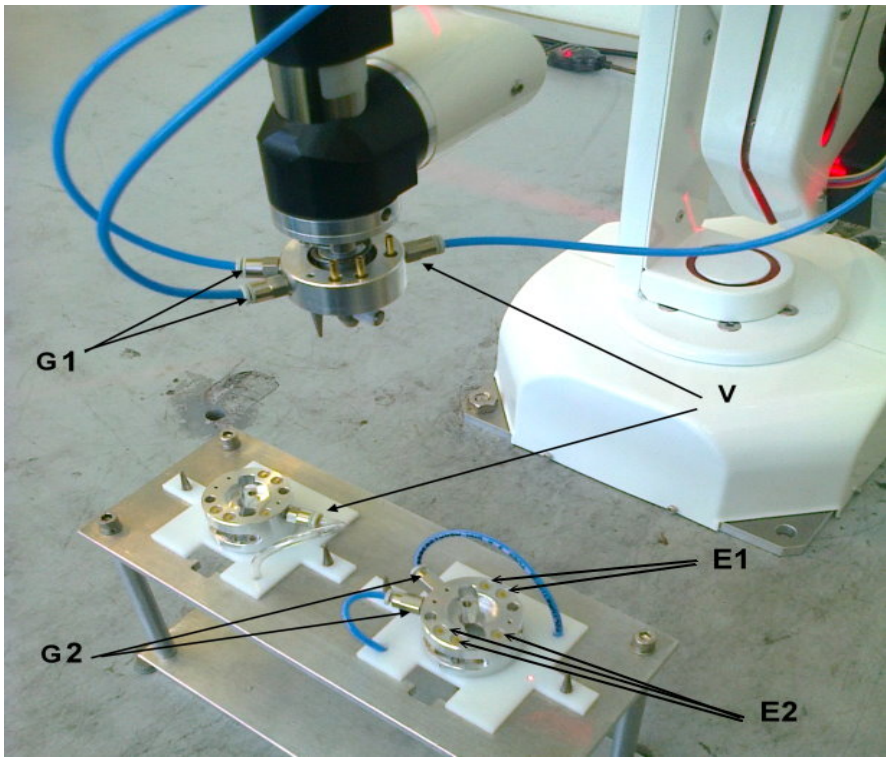


Diagram 2

Connections for pneumatic gripper are shown as G. The pair G2 on the robot-side adaptor will line up with the similar pair G2 on the tool side adaptor. Connections for the vacuum are shown as V. If there is an electric gripper this would normally be connected through the contacts shown as E1. E2 are spare. Or you can use all 5 connections for other electronic device.

The controller has an output port PA with 8 bits, 2 of which control the pneumatic valves.

Referring to the Forth definitions below (and on your cd), R12TOOLCHANGE

PA 2 selects either the vacuum or the gripper.
PA 0 turns then both on. PA 0 is controlled by GRIP and GRIPPER.
If PA 2 is ON then air goes to the gripper valve. GRIP closes the gripper and UNGRIP opens. This can only be used if the gripper is currently locked to the robot. Otherwise air will just come out of the robot-side adaptor.
If PA 2 is OFF then air goes to the vacuum valve. GRIP then sends air to the Venturi which creates a vacuum. The vacuum tube is a 3rd tube through the robot to the tool changer.
With no tool locked on the robot at all you need to turn off all the air. So both PA 0 and PA 2 should be off. PA 2 OFF diverts air to the vacuum valve and PA 0 OFF switches the air to the blocked port. The definition AIRSTOP does this.

```
: VAC PA 2 ; ( OFF = VAC, ON = GRIPPER
: VACON
VAC OFF
;
: AIRSTOP
VAC OFF GRIPPER OFF
;
```

Once you have the vacuum tool attached then just use GRIP and UNGRIP which operate PA 0 and simultaneously turn on valves V2 and V3.
.
If you have the gripper attached first do VAC ON then use GRIP and UNGRIP.
Don't forget to AIRSTOP before you disengage the tool.

If you have the vacuum pickup attached select it with VAC OFF. This may seem counter-intuitive but ensures a safe situation when the controller is switched off.

Pneumatic gripper and electric gripper.

The pneumatics circuit is as diagram 1 but without V2 or Venturi. Note that the electric gripper uses PA 0 and PA 1. PA 1 must not be used by any valve or other device.

A variable GTYPE has the value 0 for a pneumatic gripper or 1 for electric.
When you are about to use the pneumatic gripper enter
0 GTYPE !
For the electric gripper enter
1 GTYPE !

Vacuum pickup and electric gripper.

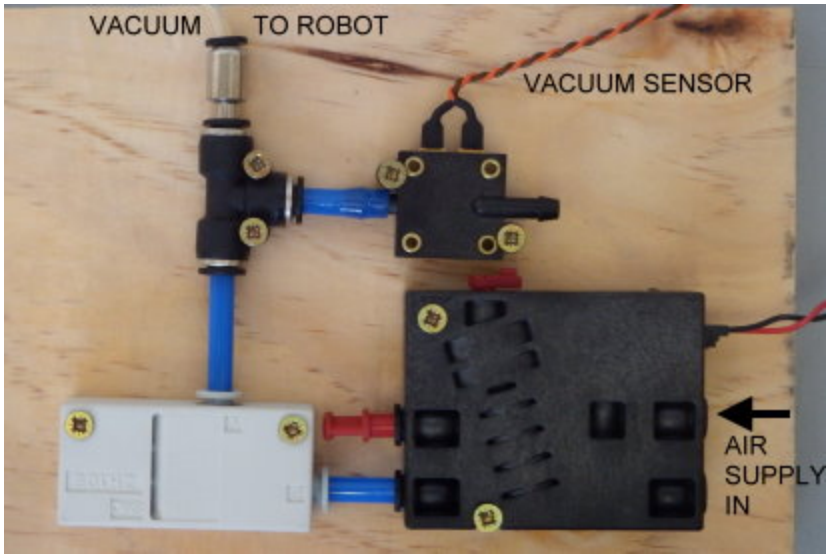


Diagram 3

```
: VAC PA 2 ; ( OFF = VAC, ON = GRIPPER
: VACON
VAC OFF
;
```

A variable GTYPE has the value 0 for vacuum pickup or 1 for electric gripper.
When you are about to use the vacuum pickup enter
0 GTYPE !
For the electric gripper enter
1 GTYPE !

Using the tool changer manually

To use the tool changer automatically you ideally need to have used the robot with a fixed end effector and learned how to program positions and projects.

Therefore it is best to fit a tool onto the robot manually and proceed from there.
To do this refer to diagram 4:

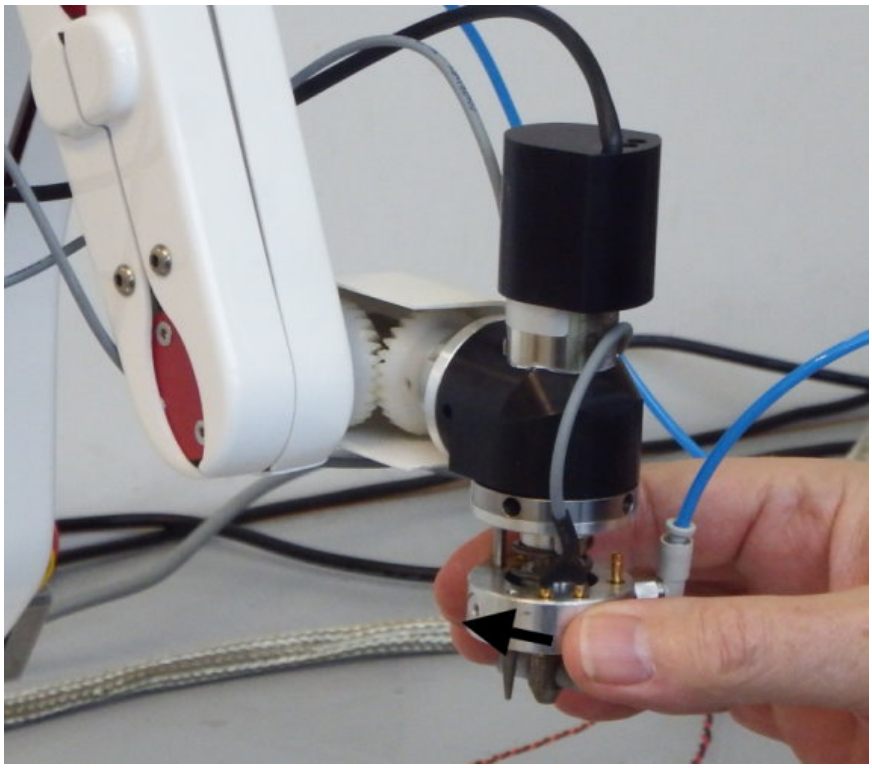


Diagram 4

Go to the safe position
READY for a 5-axis R12 or READY2 for a 6-axis R12.
The robot will end up at a position with the hand over the tool stand, pointing down.
Diagram 4 shows a 6-axis robot in READY2 position.

Find the hard stop which is a small pillar that can move against a stop. Rotate the changer by hand clockwise in the direction of the arrow as far as it will go, with the pillar against the stop.

It should now be possible to offer up a tool with its adaptor.
Push the two parts together and rotate the robot-side back the other way, locking the tool.

WARNING

Before trying any of the following commands be sure to KEEP OUT OF THE ROBOT ENVELOPE

Take great care in teaching the changer positions. Use a low speed.
If you crash the robot turn off power, take back to home and re-calibrate.
Notice:
Any damage to the robot 6th axis due to collision is not covered by warranty.

How to program the tool changer.

Before you start you must set the tool in the unlocked position by hand.

Go to the safe position
READY for a 5-axis R12 or READY2 for a 6-axis R12.
The robot will end up at a position with the hand over the tool stand, pointing down.

See diagram 4

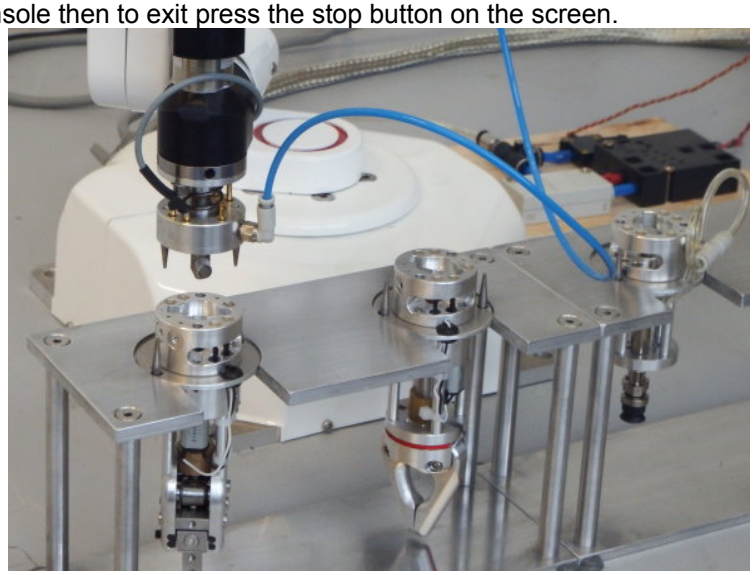
Find the hard stop which is a small pillar that can move against a stop. Rotate the changer by hand clockwise as far as it will go, with the pillar against the stop. This is essential. If at any time this gets moved while not holding a tool then you must set it again by hand.

Start a new project and create new routes. As a suggestion start with a route called TOOL1

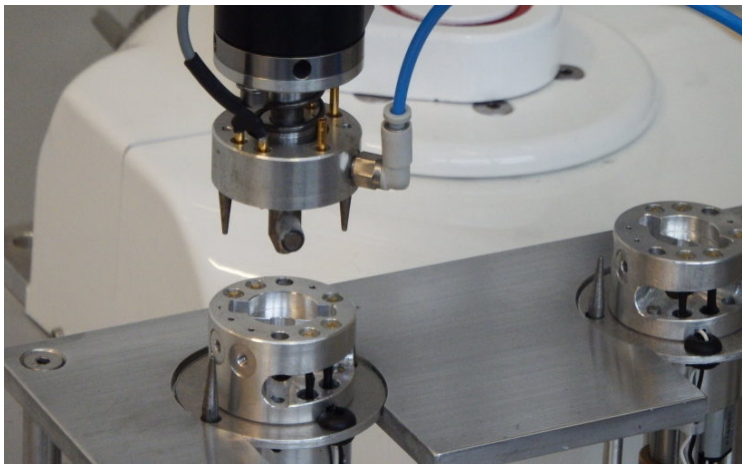
Do **not** use ALIGN (enter NONALIGN)

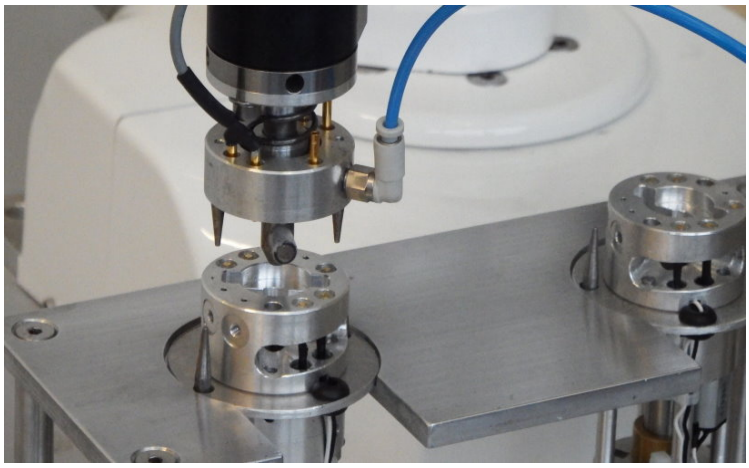
Starting with the gripper, in RobWin click routes, new, name TOOL1, Cartesian.

Next click the J (jog) button and move the robot over the rack and down towards the first tool (in this example it is an E3 electric gripper) using the teach pad in **Jog** mode. To exit Jog mode press esc. If you are using the Nexus 7 teach console then to exit press the stop button on the screen.

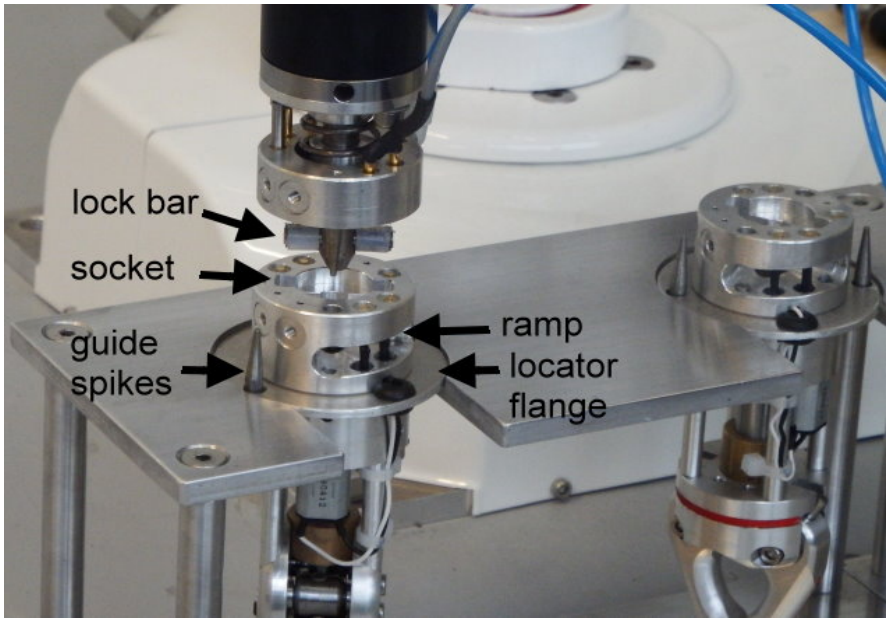


Jog down carefully

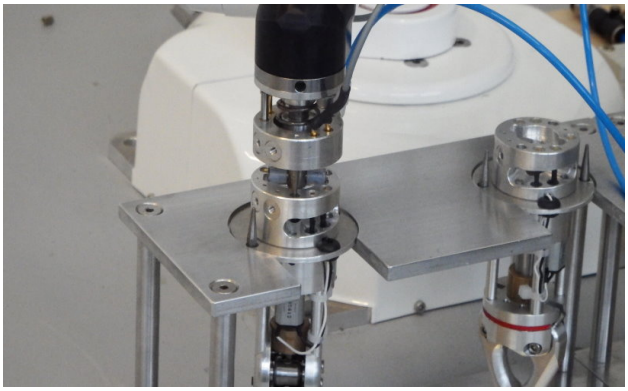


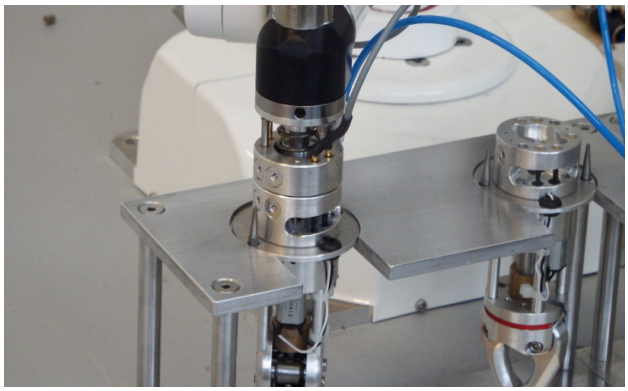


At this point use roll (J5 on a 5-axis, J6 on a 6-axis) to align the lock bar with the socket in the tool-side adapter. Watch the guide spikes going in to the holes in the locator flange as well as the lock bar.



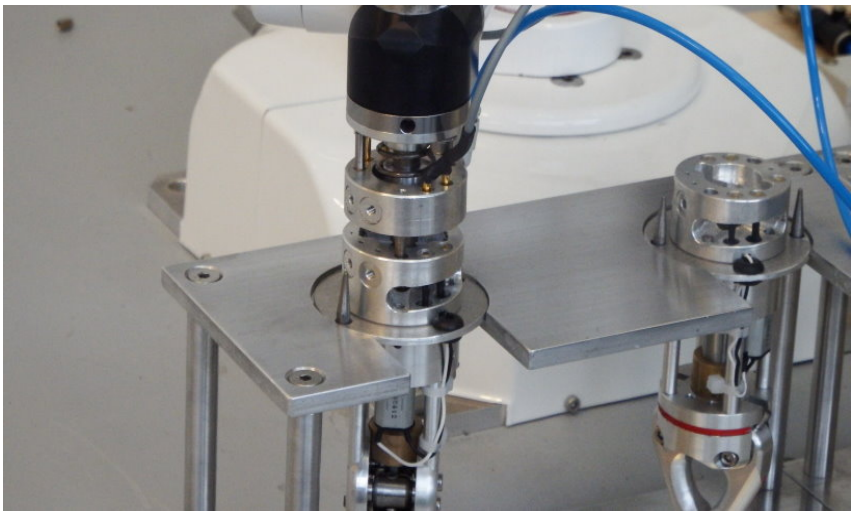
You will also need to move in X and Y axes to get the best fit. You will need to change the increment down to 1mm or even 0.1mm to get the position exact.



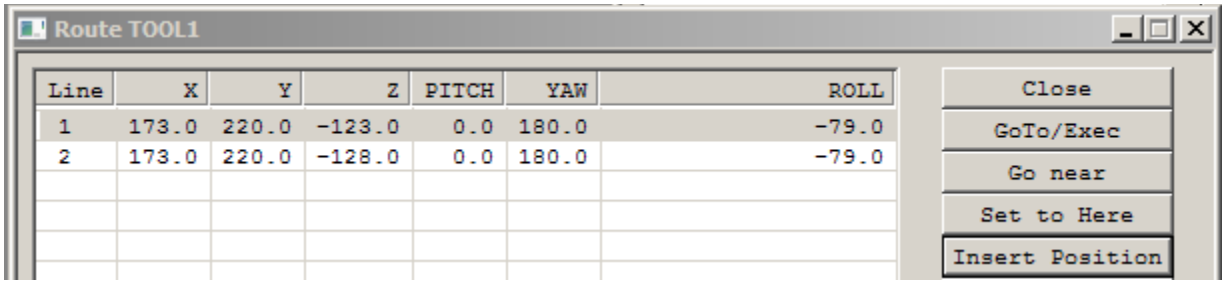


Once closed with the tool (a small gap is tolerated) exit the jog mode and click 'append position' This is line 1 of your new route:

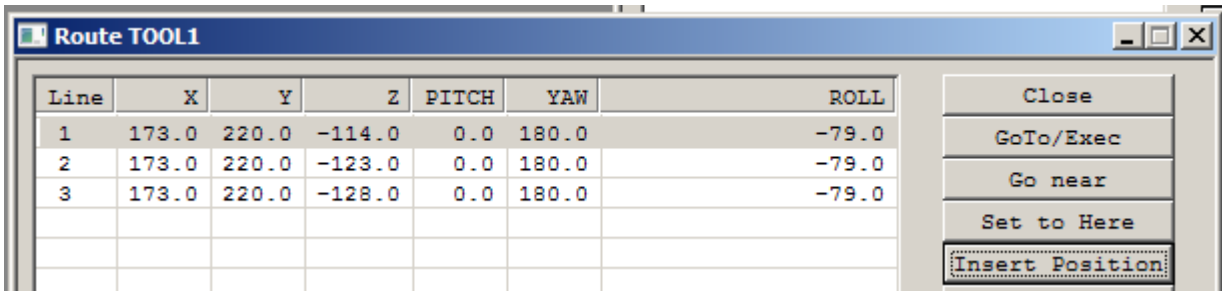
At this point we recommend changing the increment to 5mm. Jog up 5mm.



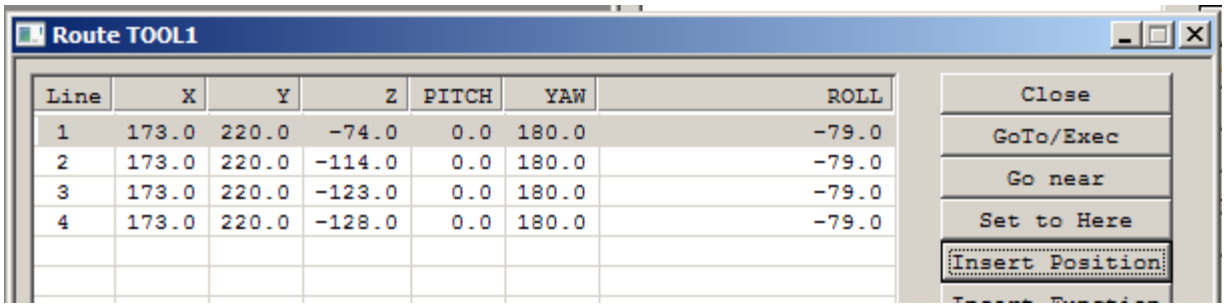
Exit Jog and click **Insert Position**



Change increment to 9mm. Move up 9mm so that the spikes are still aimed at the holes.
Exit Jog, highlight line 1 and click **insert position**. The target position is now line 3

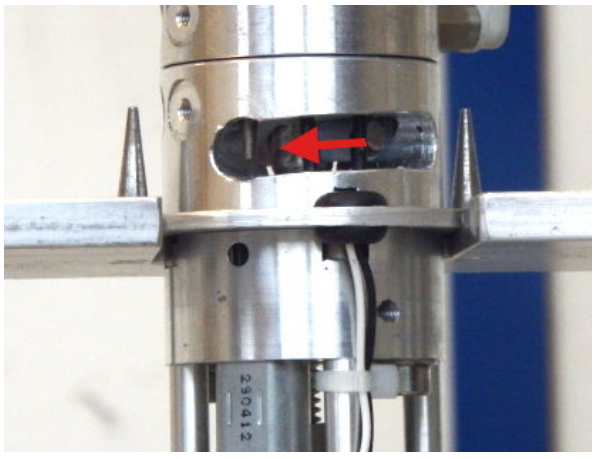


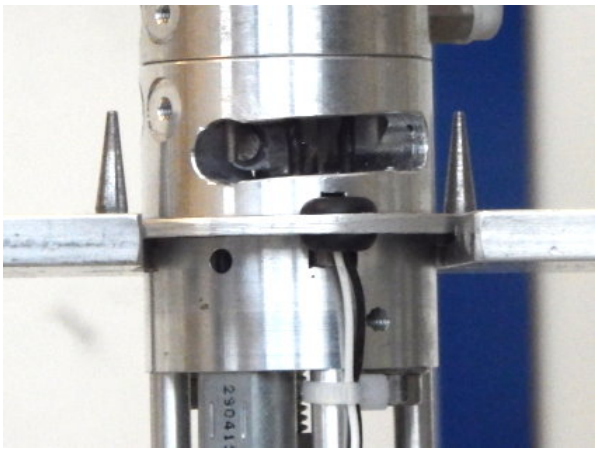
Change increment to 10mm and move up well clear. Exit Jog and click **insert position**. The target position is now line 4 with 3 positions above which are the way in,



Click line 2 and GoTo/Exec
Click line 3 and GoTo/Exec
Click line 4 and GoTo/Exec
the tool is now together.

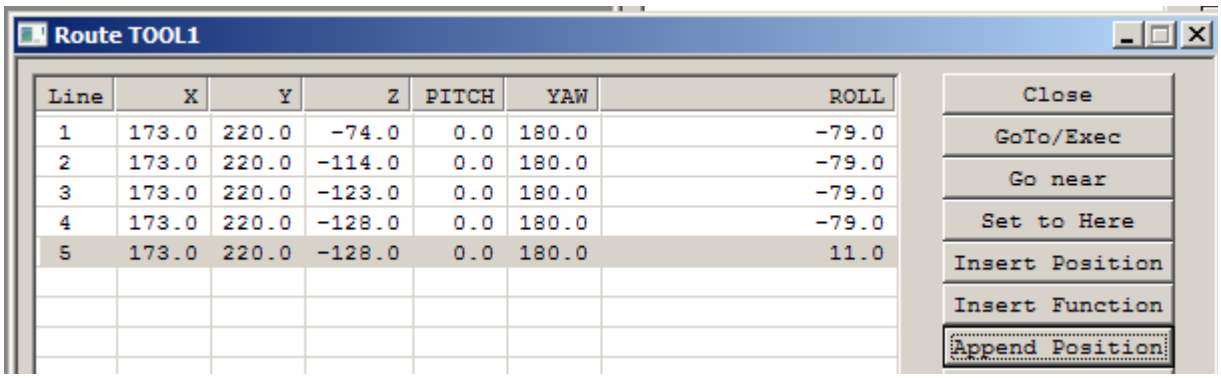
Using Jog and J6 for 6-axis or J5 for 5-axis first press WH or in the nexus press the refresh button to see the current roll angle. Rotate clockwise (seen from above) in 10 degree increments until you reach 80 degrees from where you started. You will see the T-bar in the changer move along the ramp.





Change increment to 1mm and rotate further. You should in theory need 90 degrees to get to the end of the ramp but a value of 87 degrees is typical.
The tool is now locked.

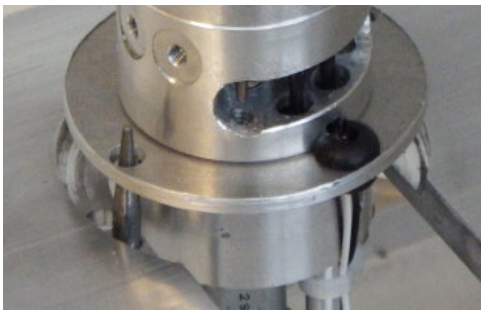
Press the tick button on the teach pad or exit the teach pad and on the route window click append position. This will be line 5

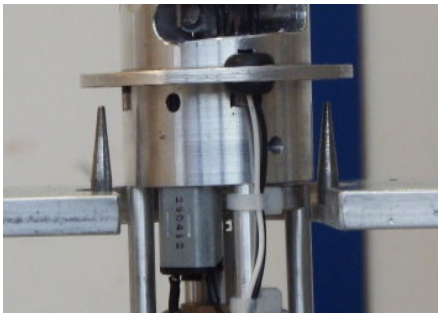


In the above example a total of 90 degrees has been moved. You may see the locator plate tight against the guide spikes. In this case rotate back again a few degrees.

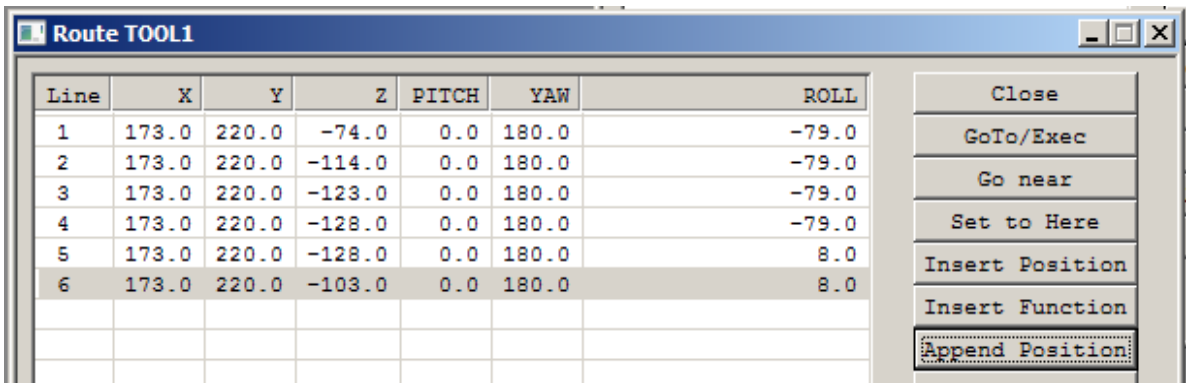
Now move up 5mm at a time until the adaptor plate clears the spikes on the rack. At this point the adaptor plate may spring further clockwise. In this case rotate back the other way in 1 degree increments until it is obvious the plate can go back down straight. Now go down on Z until the plate is flat on the rack. In the route click line 5 and **Set to Here** to replace line 5.

Go up approx 25mm clear of the guide spikes.



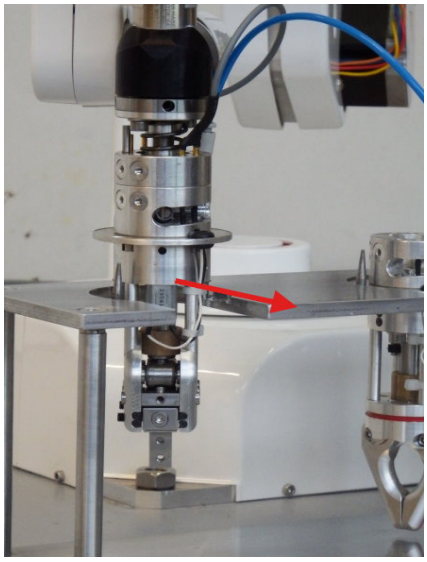


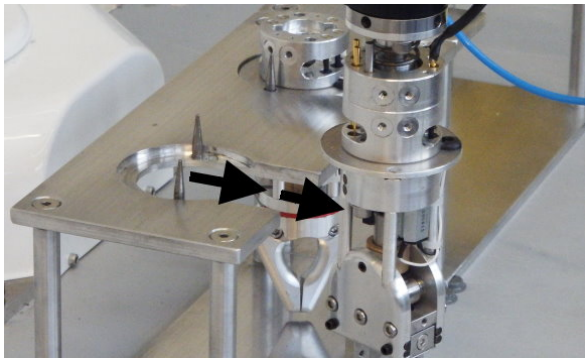
Press the tick button on the teach pad or exit the teach pad and click append position. (line 6)



The tool must now be moved sideways out of the stand.

Press the tick button on the teach pad or exit the teach pad and click append position. (line 7)



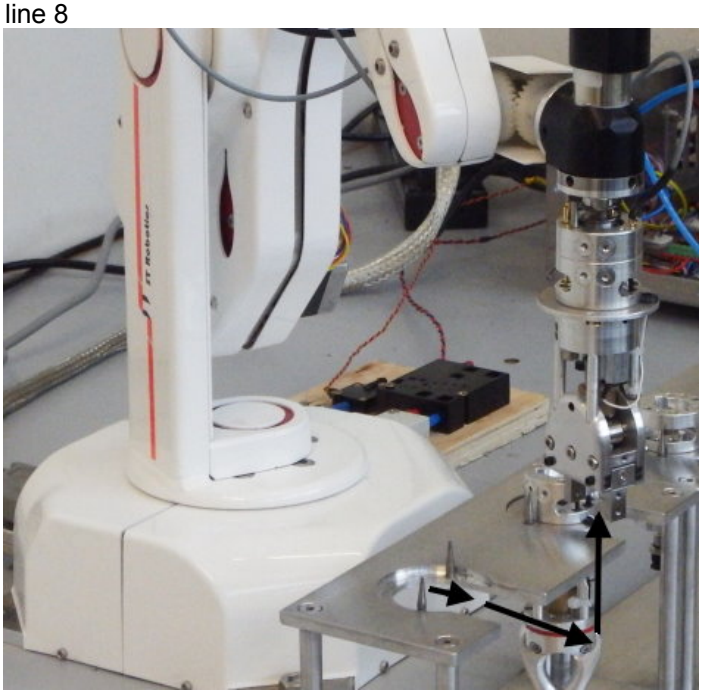


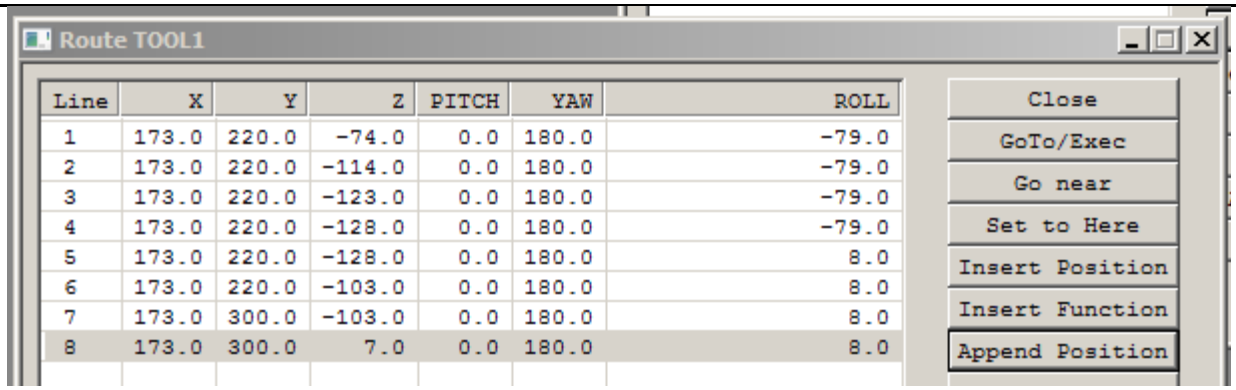
Route TOOL1

Line	X	Y	Z	PITCH	YAW	ROLL
1	173.0	220.0	-74.0	0.0	180.0	-79.0
2	173.0	220.0	-114.0	0.0	180.0	-79.0
3	173.0	220.0	-123.0	0.0	180.0	-79.0
4	173.0	220.0	-128.0	0.0	180.0	-79.0
5	173.0	220.0	-128.0	0.0	180.0	8.0
6	173.0	220.0	-103.0	0.0	180.0	8.0
7	173.0	300.0	-103.0	0.0	180.0	8.0

Close
GoTo/Exec
Go near
Set to Here
Insert Position
Insert Function
Append Position

Then move up and learn line 8





Line	X	Y	Z	PITCH	YAW	ROLL
1	173.0	220.0	-74.0	0.0	180.0	-79.0
2	173.0	220.0	-114.0	0.0	180.0	-79.0
3	173.0	220.0	-123.0	0.0	180.0	-79.0
4	173.0	220.0	-128.0	0.0	180.0	-79.0
5	173.0	220.0	-128.0	0.0	180.0	8.0
6	173.0	220.0	-103.0	0.0	180.0	8.0
7	173.0	300.0	-103.0	0.0	180.0	8.0
8	173.0	300.0	7.0	0.0	180.0	8.0

The route is complete.

Test

reduce speed for the test
1000 SPEED !
Have your hand over the stop button.

Test in the reverse direction
This puts the tool back and lifts clear,
You have 8 lines. Click line 7 and goto. Then 6,5,4 etc. The robot should unlock the tool and move up.
Test in the forward direction.
Click line 1, goto, 2 goto etc. The robot now has the tool.
Test in the reverse direction
SEGMENTED
TOOL1 RETRACE
This puts the tool back and lifts clear,
Test in the forward direction.
TOOL1 RUN
This gets the tool from the rack.
Follow a similar procedure for the other tools, e.g. TOOL2 TOOL3 etc.

Why use SEGMENTED mode:
CONTINUOUS and SMOOTH are smoother but you can not round the corners before and after rotating in the tool adaptor since it must be fully seated before rotating. If you want to make it smoother create 2 routes for each tool, one for the way in and one for the way out.

Recovery

If the robot crashes for any reason proceed as follows
ENCOFF
Use Jog to get away from the accident.
HOME
START
CALIBRATE
Check/reset the tool to the unlocked position by hand.
Find the hard stop which is a small pillar that can move against a stop (a screw head). Rotate the changer by hand anti-clockwise then clockwise again as far as it will go, with the pillar against the stop. This is essential. If at any time this gets moved while not holding a tool then you must set it again by hand.

Programming.
You could have words like these

```
: VAC PA 2 ; ( OFF = VAC ON = GRIP

: SLOW 1000 SPEED ! ;

: VACON
VAC OFF
;
: GRIPON
VAC ON
;

: AIRSTOP
VAC OFF GRIPPER OFF
;

: GETEG ( GET ELECTRIC GRIPPER
TOOL1 RUN
1 GTYPE !
;
: PUTEG
TOOL1 RETRACE
;
: GETVAC
TOOL2 RUN
0 GTYPE !
;
: PUTVAC
TOOL2 RETRACE
;
```

Suppose you have an electric gripper in stand position 1, a vacuum pickup in position 2 and a pneumatic gripper in position 3

```
: GETEG ( GET ELECTRIC GRIPPER
AIRSTOP
TOOL1 RUN
1 GTYPE !
;
: PUTEG
TOOL1 RETRACE
;
: GETVAC
TOOL2 RUN
0 GTYPE !
VACON
;
: PUTVAC
AIRSTOP
TOOL2 RETRACE
;
: GETPG
TOOL3 RUN
0 GTYPE !
VAC OFF
;
: PUTPG
AIRSTOP
TOOL3 RETRACE
;
```