

Getting started with ROBWIN 7 and ROBOFORTH II v15 up

RobWin © Sands Technology International.

This is a Windows based application which runs in the computer. It communicates with the robot controller and also saves robot software on disk. It keeps an identical copy of the controller data in memory while you use it.

Roboforth II © D. N. Sands.

This is a complete system which resides in the robot controller. It is based on the FORTH control language. It is extensive but not greatly complex. As with any software the best way to learn it is to use it. This document walks you through basic motions and creation of simple tasks.

Note: Only type what is underlined. When you've typed it press the enter key.

Programming the robot requires communication with the robot controller. When ROBWIN is running there is a communication window. You can type things in this window and they are sent directly to the controller i.e. this window is like a terminal. ROBWIN also sends commands to the controller, most of which appear in the communication window. ROBWIN also has the ability to download data to the controller and upload data from it, and can save or reload data from disk.

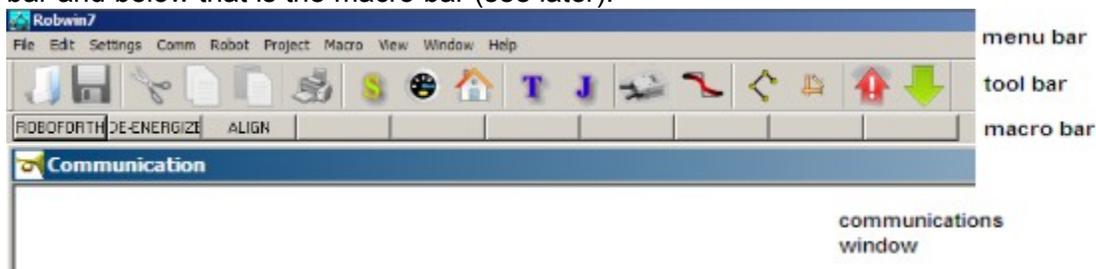
Once you are in ROBWIN you can click on Help to get an explanation of any command or variable which may be sent by ROBWIN. For all other ROBOFORTH commands use the glossary or the manual. You can also click on the help button which is an arrow plus a question mark. A large question mark appears by the cursor which you then take to a tool bar button or any menu command for an explanation of that function.

Install

Simply copy RobWin7.exe, all cfg and mac files to your hard drive. Create a shortcut on desktop if required.

Launch

Double-click on the ROBWIN icon. Along the top are the menu buttons, below that is the robot tool bar and below that is the macro bar (see later).



Load/check settings: On the menu bar click settings, open file. Select r12-6.cfg. Axis names may be manually set using settings.

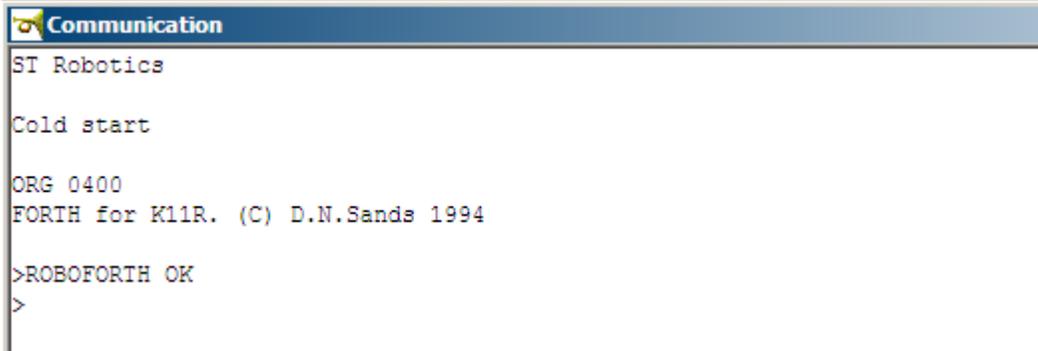
caps lock – All ROBOFORTH commands are in upper case, ensure CAPS LOCK is on.

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Switch the key switch to cold start and switch on the robot controller.

In the communications window (the console) you should see a herald which includes the words 'cold start' (see below) and a chevron prompt >.

Type ROBOFORTH into the console. The response should be OK and a new line with a chevron prompt >



```
ST Robotics
Cold start
ORG 0400
FORTH for K11R. (C) D.N.Sands 1994
>ROBOFORTH OK
>
```

Note: When you type anything in the console all buttons are grayed out. If you back off what you typed they will still be greyed. Press **esc** if in doubt.

In the tool bar press the start button  or type START into the communications window. This energizes motors, zeros all position counts, sets default values for SPEED etc.

Press the Calibrate button  or type CALIBRATE Robot moves to the calibrate position and calibrates all axes. Note the robot must be in an approximate home position before you do this. See the R12 and R17 manuals for images of the home position.

Press the Home button  or type HOME Robot moves to the HOME position in which all motor counts are zero. The R12 goes to home automatically after CALIBRATE.

Basics of FORTH

Forth is a language comprised of 'words' in a dictionary. Each word is a definition of a procedure defined in terms of words further down the dictionary. A word may be spelled with any characters on your keyboard, for example HOME is a word and + is a word.

Values or 'arguments' that the words need are put on a stack for the word to use up. For example 1000 STEPS moves a selected joint 1000 steps. The value 1000 goes in the stack and is used up by the word STEPS.

If you wanted to add 4 and 5 and print the result you would enter

4 5 + .

the value 4 is put on the stack, then the 5. Then the word + picks them both off the stack, adds them together and leaves the result (9) on the stack. The word . (dot) which is a Forth short-form for print then takes the number off the stack and displays it on the screen.

Teaching the robot is in 2 stages:

First **move** the robot to the desired position, second **learn** that position.



WARNING

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

MOVEMENT

Try these commands in the communication window:

RELATIVE COMMANDS

TELL WAIST 1000 MOVE Moves waist 1000 motor counts. (1000 MOVE not MOVE 1000)

The response is OK when the motion is complete.

1000 MOVE Waist still selected, moves another 1000

-3000 MOVE Waist moves back 3000 counts.

Note that the value (argument) comes *before* the command not after.

WHERE Displays current position of the robot.

TELL SHOULDER 5000 MOVE Moves R12/R17 shoulder 5000 motor counts.

ELBOW 2000 MOVE (without TELL) adds elbow to selection both move 2000

TELL SHOULDER REVERSE 2000 MOVE Moves the shoulder back again 2000 counts

TELL HAND 2000 MOVE Pitches the hand 2000 counts

Note this axis is actually 2 motors driving through a differential. The gear ratios on each motor are slightly different so the yaw axis will appear to rotate slightly as you pitch the hand.

TELL R-HAND 2000 MOVE Rotates the yaw axis 2000 counts.

TELL WRIST 2000 MOVE Rotates the roll axis 2000 counts (gripper rotates).

Other joint names are:

L-HAND selects just the left motor of the hand.

ALL selects all the joints at once.

ALL 500 MOVE moves all the joints 500 motor counts.

5000 TWIST rotates the wrist 5000 motor counts. Does not change the previous selection of joints.

ABSOLUTE COMMANDS

TELL WAIST 2500 MOVETO Moves the waist until its total count is 2500.

WHERE Redisplay position of robot to show this.

UNTWIST Rotates the wrist back to its zero count position.

(Same as TELL WRIST 0 MOVETO)

note that WHERE may show J4 and J5 are not zero but the actual positional difference may be zero.

You can do similar things with dialog boxes:

Click Robot then Joint Relative Move for the MOVE command or Joint Absolute Move for the MOVETO equivalent. These dialog boxes allow different values for each joint.

OTHER COMMANDS

HOME Moves all the joints to their zero count positions, collectively.

or click on the home button 

GRIP Closes the gripper.

UNGRIP Opens the gripper

or click.  which toggles grip open/closed

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CONTROLLING SPEED AND ACCELERATION

There are two variables SPEED and ACCEL which control speed and acceleration.

In the communications window

Type SPEED ? The controller tells what is current speed factor. Range: 2-65000

Type 5000 SPEED ! Sets the arm speed to factor 5000.

SPEED ? Confirms new speed factor.

Try it with, for example:

TELL WAIST 4000 MOVE 0 MOVETO

The acceleration is set by the value of ACCEL. Range 100-5000

1000 ACCEL ! Sets acceleration to 1000

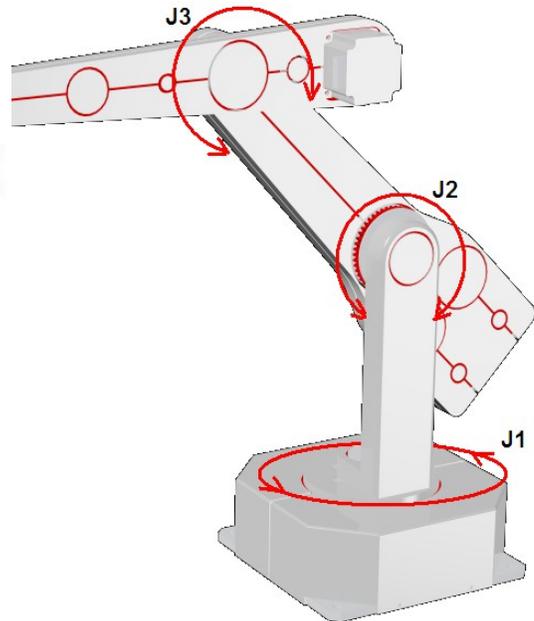
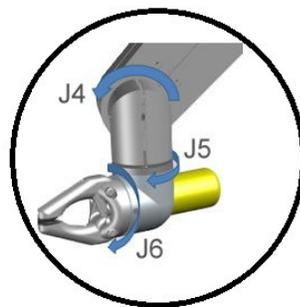
ACCEL ? Reports acceleration.

Try above motion with different values of ACCEL

NOTE: SPEED must not be more than 16 times ACCEL.

MOVING ROBOT WITH THE TEACH PAD

Press the **T** button. (red teach LED lights – green already on) The computer asks for a teach speed which defaults to 16. Don't type or click anything, pad is ready to use.



Press J1 to J6 to select a joint then press and hold **+** to go forward, **-** to go back.

J1 is waist, J2 is shoulder, J3 elbow, J4 hand (pitch), J5 yaw, J6 is wrist roll.

Press **+** and hold Moves the selected joint forwards.

Release the **+** key Stops movement.

Press **-** and hold Moves the selected joint in reverse.

Release Stops movement.

To increase the speed press **SPEED** then **+**; to decrease press **SPEED** then **-**. This is confirmed on screen. Re-select the joint to continue movement at the new speed.

Press the **WH?** key Displays current position of the robot. (same as **WHERE**)

Press the **H** key Moves all the joints to their zero positions, Same as **HOME**.

Press **GRIP** Selects the gripper.

Press **[+]** Closes the gripper.

Press **[-]** Opens the gripper.

The ✓ and ✗ are learn and delete - DO NOT PRESS AT THIS TIME.

Press the **[esc]** key on computer to exit teach pad.

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CARTESIAN COORDINATES

Type HOME or click  button to make sure the robot is at HOME

Now click the Cartesian button . Command sent to controller is CARTESIAN but ROBWIN also knows about it. Now on the menu bar click **Robot Cartesian position**. This displays the Cartesian position of the robot at home. Or you could have typed WHERE in the communication window which reports the current position of the robot in Cartesian coordinates. There are 6 possible values:

X Distance along X axis from the origin in mm.

Y Distance along Y axis from the origin in mm.

Z Distance along Z axis from the origin in mm.

Pitch: The angle of the hand to horizontal. Controller variable PITCH

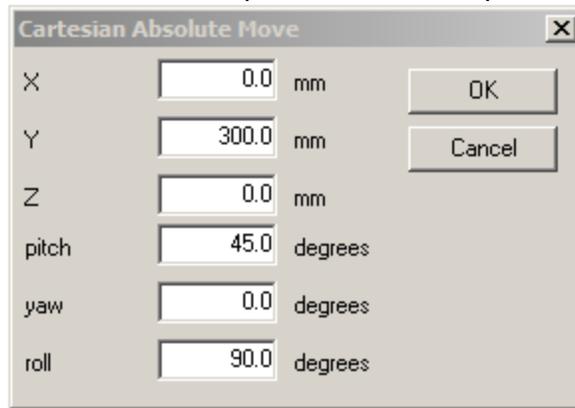
Yaw: The angle of the hand to horizontal. Controller variable YAW

Roll: The angle of the hand to horizontal. Controller variable ROLL

The origin (0,0,0) is at the intersection of the shoulder and waist axes. The X-Y-Z position described is the position of the intersection of the wrist rotate and hand (wrist pitch) axes.

Click robot, Cartesian abs. Move

This displays the current position of the robot and permits you to enter new values as required. When you click MOVE or OK the robot moves to that position. For example



The screenshot shows a dialog box titled "Cartesian Absolute Move" with a close button (X) in the top right corner. It contains six input fields, each with a numerical value and a unit label to its right. To the right of the input fields are two buttons: "OK" and "Cancel".

Parameter	Value	Unit
X	0.0	mm
Y	300.0	mm
Z	0.0	mm
pitch	45.0	degrees
yaw	0.0	degrees
roll	90.0	degrees

This will move the robot to zero on the X axis, 300mm from center on the Y axis and zero on the Z axis (which means level with the shoulder pivot). The hand pitches to 45 degrees, yaw stays pointing forward (along Y axis) and the wrist rotates 90 degrees.

NOTE: The R12 will not assume a low Z value with the hand pointing up (-90.0 deg). This is because there is a software trap to prevent the hand colliding with the covers.

CARTESIAN COMMANDS

Alternatively in the **communications window** you can use MOVETO and MOVE which in CARTESIAN mode now require 3 values (arguments). MOVE is still relative and MOVETO is still absolute.

But first it's best to get the robot down into a safe working position with the command

READY

This is with the tool pointing horizontally. You can see the full position with

WHERE

To get the tool initially pointing downwards enter

READY2

WHERE

Now you can try the MOVE and MOVETO commands:

0 400.0 0 MOVETO Moves the robot to X=0, Y=400.0 mm, Z=0.

0 4000 0 MOVETO Robot does not move because 4000 is the same as 400.0

0 100.0 0 MOVE Robot moves additional 100.0mm

WHERE Display new position of robot.

PREV line indicates previous position.

TOOLSET This is a command to change the variables PITCH, YAW, ROLL

(note resolution of angular values is 0.1 degrees)

Example:

WRIST PITCH enter 900 (90 degrees) To move hand to horizontal.

WRIST YAW enter 450 (45 degrees.)

WRIST ROLL enter 0

ALIGN? just press enter.

EXECUTE? press Y

MOVING ROBOT WITH THE TEACH PAD IN CARTESIAN MODE

Again its best to start from READY

Press the  button (Jog). ('Jog' LED lights) The computer asks for an increment which defaults to 10mm. Don't type or click anything, pad is ready to use.

(You can enter a new increment first if you wish but keep the default for now. The largest value you can enter is 25.5 and remember that 25.4 is one inch.)

On the keypad select X Y or Z.

Then press + or – one time (not press and hold as before). On each press the robot moves in that axis by the set increment. To increase the increment press SPEED then +; to decrease press SPEED then – Then press the X Y or Z key again and + or – to move a different axis.

J4 selects the hand pitch – an increment of 10.0 means 10 degrees.

J5 selects yaw – an increment of 10.0 means 10 degrees.

J6 selects gripper rotate (roll) – an increment of 10.0 means 10 degrees.

MOVING ROBOT WITH THE NEXUS

Please see separate instruction manual.

TEACHING THE ROBOT

Open a project

Click **project, new** and choose a name for your project for example **myprog**.

When the project is open you will see three more windows: routes, places and a window labeled myprog.ed2

We advise (from experience) to move the communications window to the bottom and to re-arrange the other three so all are visible.

The system sends commands ROBOFORTH and STARTOVER to the controller which you can see in the communications window. This clears out the controller ready for the new session.

Teaching the robot is a process of moving to a position and learning that position. There are two devices for learning robot positions:

a ROUTE - this is a named list of positions which the robot follows in sequence.

a PLACE - this is a named single position to which the robot will go when required.

The user must choose which is most suitable for the task and must also choose a name which describes what the route or place means in the context of the application.

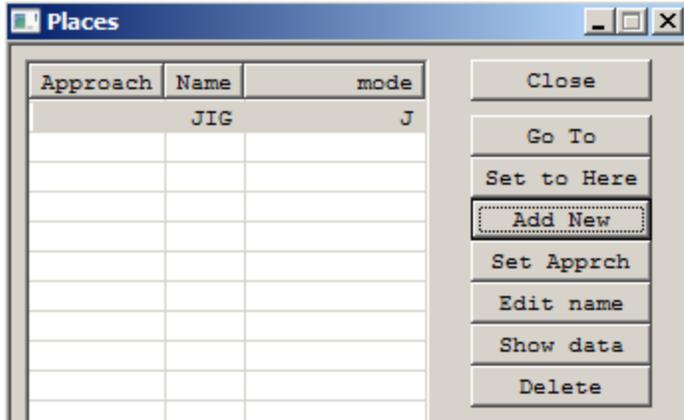
A task can involve more than one route or place or a mixture. All the routes and places will be saved together by ROBWIN in 2 files regardless of how many routes or places you have.

PLACES

Move the robot to any position you like using any of the methods described above.

Click the Places dialog box. If you can't see it click **Project > Places** This brings up list of existing places (empty).

Click **Add New**, enter a name for the place, for example JIG and click OK.



To make the robot move to this position click the communications window and enter the name of the place, for example suppose the place name were JIG. Enter:

HOME robot goes to home position

JIG robot moves back to the place position.

If you regard this position as a target position you can now move the robot back to a position which is safe for the robot to move to before it goes into the target position. You then click on **Set Approach** in the Places window. The PLACE now has two positions: the approach position and the target position.

Example of using this feature

HOME Moves all the joints to zero count positions.

JIG Moves robot to JIG via the approach position.

WITHDRAW Moves robot back to the approach position.

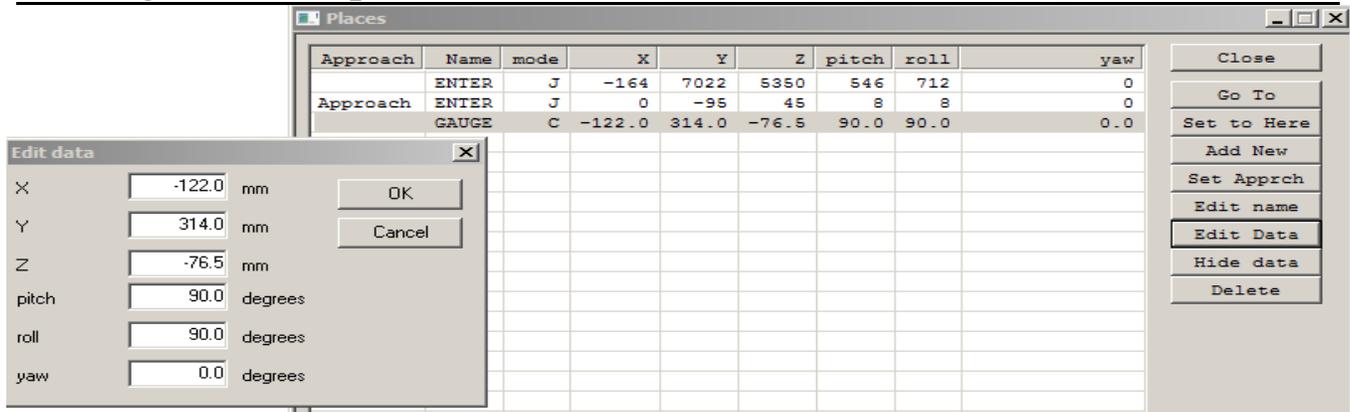
Only ever use the withdraw command after the place name has been executed.

Note: just creating the place was enough to record it's position. Just entering the place name is enough to move the robot there. A Place is self learning and self executing.

If you want to change the coordinates of a place move the robot to the new position and click on the **Set to here** button.

In the Places window you will also see a mode J or C. If you create a place while you are in JOINT mode the coordinates learned will be joint coordinates and the mode will be J. If you create the place while you are in CARTESIAN mode then the coordinates learned will be Cartesian and the mode will be C. If you execute a place-name by typing its command, if the place is a J type the robot will go to the joint coordinates within that place and the system will change to JOINT mode. If the place is a C type the robot will go to the Cartesian coordinates within that place and the system will change to CARTESIAN mode.

If you click **Show data** the places window opens up to show the actual coordinates learned for each PLACE.



You can now edit the data manually if you wish. Click the name of the PLACE. That line is highlighted and the header line at the top changes to show the coordinates names (Joint or Cartesian). Click edit data to edit a line. A new box appears and you can change the value in any box. Click OK to save the new value(s). You can also delete or rename a PLACE. However this may cause the project to be reloaded to get the words in the right order.

Example pick and place program

Learn a place, called, say JIG with an approach position.
 Learn a second place, called say FEED with an approach position.
 Select (click) the .ED2 window and write in the following program:

```

: TEST
FEED
GRIP
WITHDRAW
JIG
UNGRIP
WITHDRAW
HOME
;
    
```

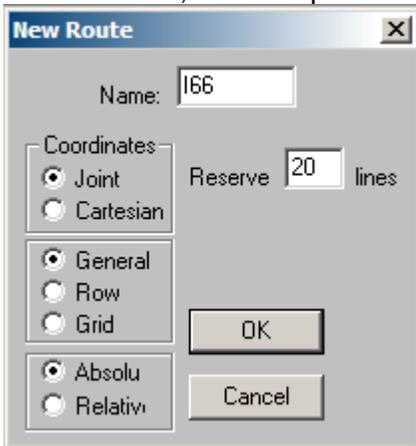
Click the down arrow  to download to the controller.
 Enter TEST to try it If you need to change it click the ed2 window again and when you have edited the text click  again to download to the controller.

ROUTES

Find the **routes** window or click **Project Routes**.

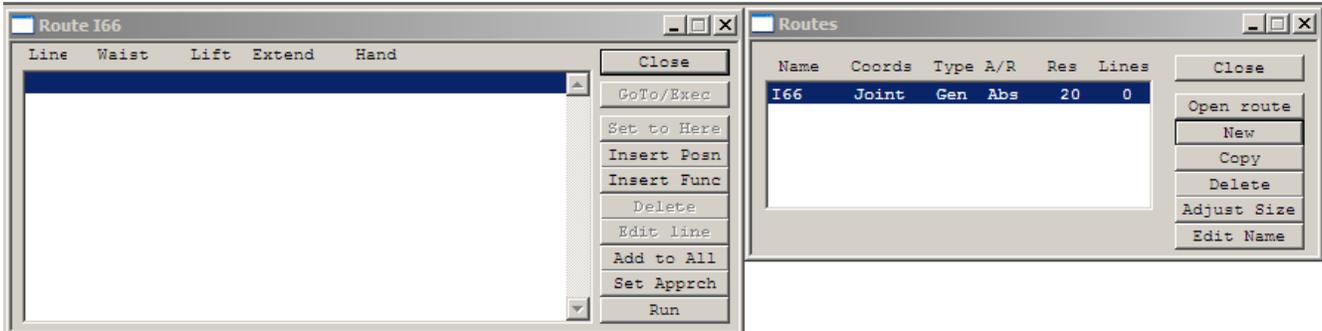
Click the **New** button

Enter a name, for example I66



You must then reserve some space for the route. The default is 20 but you can reserve hundreds if you think you'll need them.

Click OK and this creates a window for the new route:

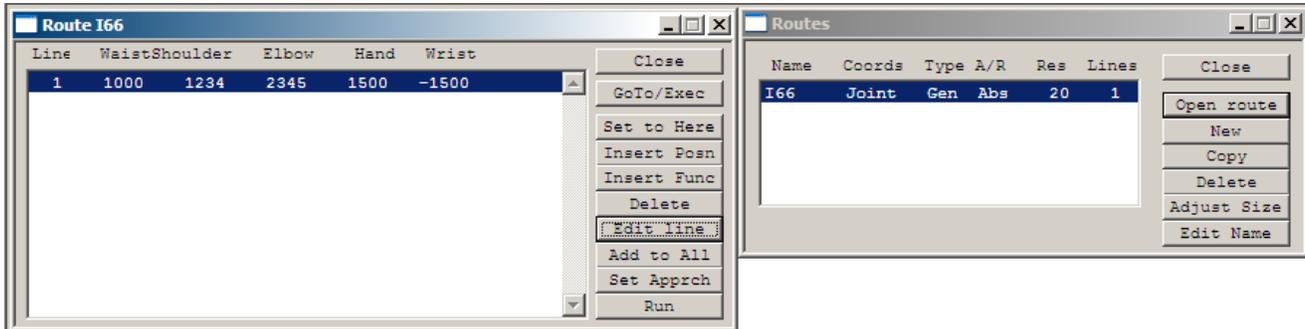


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Learning

Move the robot to desired position using any method described above. If using the teach pad press escape, don't press the tick key.

Click **Insert Posn**



For the next position highlight the next blank line and click **Insert Posn** again. Don't forget to click back inside the communications window before you type a command.

To RUN a route type RUN in the console (communication window). The robot will run from point to point stopping at each learned point.

To keep the robot running through all the points without stopping enter CONTINUOUS then RUN. (on same line or one line at a time, it makes no difference)

If you see 'too tight line....' then type ADJUST then RUN again. A new speed is announced.

The opposite of CONTINUOUS mode is SEGMENTED.

Editing a route

To change the data in a line move robot to new position, highlight the line to change and click **Set to Here**

To insert a line move the robot to desired position, highlight the line and click **Insert Posn**. The new line will be inserted in front of the highlighted line.

You can also edit the actual data in a line with **Edit Line**

You can also insert or learn a function with **Insert Func**. The function could be, for example GRIP or UNGRIP. These commands will then be carried out as the robot runs through the route.

The Insert Func also asks for a value. GRIP and UNGRIP require no value but you could, for example, change speed by inserting function SPEED then a value. The DSP speed will then change when the robot gets to that line. It will stay changed until set to another value. Another possible function is MSECS with a value, for example MSECS then 1200 inserts a 1.2 second delay.

You can only run a route with these functions in segmented mode (see manual).

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USING THE TEACH BOX TO LEARN A ROUTE

Click on  button or button to activate the teach pad, as described above. Do not type TEACH – it is not the same. When satisfied with the position press the red  key. This learns the position into the currently selected route. To delete the last line learned press and hold the FN key then press the red  (the fn key is like a shift key).

You may of course have many routes and places. A place is self-learning (adopts the current position of the robot when it is created) and self executing (just type its name to make the robot go there). When you have more than one route you need to type its name to make other commands relevant, for example RUN (e.g. I66 RUN, PATH2 RUN etc). Likewise the tick  on the teach box learns a new position into the selected route (e.g. I66 then TEACH).

SAVING ON DISK

Click **Project Save**.

The computer maintains 3 files, types RUN, ED1 and ED2 for example:

myprog.run - contains all the positional data in binary.

myprog.ed1 - contains a list of the route and place names in the same order as they were created.

DO NOT EDIT THIS FILE

Also a third file myprog.ed2

CREATING A TASK WITH BOTH ROUTES AND PLACES

Click on the ED2 window. You can now enter definitions in this window, for example

: TASK

JIG

I66 RUN

:

To download this file to the controller click on the  button. This also automatically saves the file to disk.

To test this function simply type

TASK

A variation might be:

: TASK

10000 SPEED !

JIG

20000 SPEED !

I66 CONTINUOUS ADJUST RUN

10000 SPEED !

:

Each time you click the download button the new text is automatically saved however you need to click **project, save** to save the data on disk. The text is saved in the third file, myprog.ed2.

You can also save the project in the controller Flash EPROM using the command

USAVE

If you switch off and on the controller with the front panel key in the warm start position the data and programming are restored from Flash EPROM. It is still necessary to use START and CALIBRATE.

You are now familiar with the basics of ROBOFORTH and ROBWIN. For more advanced programming please refer to the software reference manual.