# SECTION II

## FUNCTIONAL CHAINS OF THE ROBOT

TRANSMISSION VIA V24 SERIAL CONNECTION

Wait a few seconds: Software being loaded

While the software is being loaded a presentation message is visualized on the display screen.

Once the loading has been complete, the following message appears:

PERFORM THE RESETTING OF BOARD 45000 AND THEN
DEPRESS A KEY

Depress the red button located on the board, then depress a keyboard key to continue. At this point the main menu will appear:

| MAIN MENU | |
|---|---|
| 1 LEARNING | 6 CATALOGUE |
| 2 CONSTRUCTION/UPDATING | 7 LISTING |
| 3 EXECUTION | 8 FLEXIBLE CELL INTERFACE |
| 4 READING ON MAGNETIC DISK | 9 NEW PROGRAM |
| 5 SAVING ON MAGNETIC DISK | 10 EXITING |
| YOUR CHOICE : | |

Users are offered nine possible choices:
- choices 1,2 and 3 concerning robot programming
- 4,5,6 concern program saving and recovering
- 7 makes it possible to obtain a listing, on the screen or as a print-out
- 8 enables the user to create a program for use in flexible workshop system
- 9 restarts the working memory.

Caution: choices 4 (reading on magnetic disk) and 9 restart the memory.

## Choice 1: Learning

| LEARNING | |
|---|---|
| 1 BASE | 6 GRIPPER |
| 2 SHOULDER | 7 SIMULTAN. MOVEMENTS |
| 3 ELBOW | 8 OUTPUTS |
| 4 WRIST 1 | 9 TIMING |
| 5 WRIST 2 | ESC RETURN TO PREVIOUS MENU |
| YOUR CHOICE : | |

During this phase, you will "teach" the robot the movements it will have to perform automatically later on.
Select the desired command to make the robot perform a movement.
By depressing the "Eschap" key (ESC) you can stop the learning session and return to the main menu.

Remark: if a program is already stored in the memory, it must be executed before starting the learning process.

| MOVEMENTS | |
|---|---|
| | INCREMENT |
| | DECREMENT |
| | INCREMENT BY 10° |
| | DECREMENT BY 10° |
| Input | VALIDATION |

| STEP: | MOVEMENT: | VALUE: |
|---|---|---|

You have selected one of the following five commands:

- 1 for BASE (B)
- 2 for SHOULDER (E)
- 3 for ELBOW (C)
- 4 for WRIST 1 (D)
- 5 for WRIST 2 (F)

You can move the robot by means of the four slider arrows.

The last row will display the step being treated, the letter denoting the selected command, the movement value.

Remarks: - Movement values are given in degrees.
The end limits are:
- 130 < B < 130
- 43 < E < 43
- 125 < C < 125
- 90 < D < 90
- 90 < F < 90

- You can activate the slider keys as many times as you wish. When the correct value has been reached, depress "ENTER" to confirm the step and be able to return to the learning menu and go ahead with another movement.

| GRIPPER | |
|---|---|
| 1 OPENING<br>2 CLOSING<br><br>Enter VALIDATION | |
| STEP: | STATUS: |

You have selected the gripper command. The last row shows the value of the current step and the gripper status: open or closed. You can modify this condition by depressing the relative key (0 or F).

By depressing ENTER you can confirm your choice and will return to the learning menu.

| SIMULTANEOUS MOVEMENTS | |
|---|---|
| 1 BASE<br>2 SHOULDER<br>3 ELBOW<br><br>ESC END | INCREMENT<br>DECREMENT<br>INCREMENT BY 10°<br>DECREMENT BY 10°<br>Ent VALIDATION |
| STEP:<br>BASE VALUE:<br>SHOULDER VALUE:<br>ELBOW VALUE: | |

You have chosen the simultaneous movements command.

Movements are saved in sequence. It is only during the execution that the movements are performed simultaneously. First of all, select a movement by depressing keys 1, 2 or 3. The chosen item will blink at the botton of the screen. The, introduce the desired value by depressing the slider movement keys. At this point, use "ENTER" to validate your selection.

Repeat this procedure for each movement, as many times as you wish. By depressing "Eschap" you can confirm the whole series of movements in the current step.

Remark: key "Eschap" is active only before selecting a movement.

| OUTPUTS | |
|---|---|
| 1<br>2<br>3 No. OF OUTPUT<br>4<br>5<br>6<br>7<br>8<br>ESC END | <br><br>1 DISACTIVATION<br><br>2 ACTIVATION<br><br>3 CHANGE STEP<br><br>ENTER VALIDATION |
| STEP: OUTPUT No.: STATUS : | |

You have decided to work on the outputs. Select the output to be treated through its number, then the desired condition. The last row sums up this information.
Remark: during a single step, you can activate more than one outputs: aftern confirming one status by means of "ENTER", depress the key that corresponds to another output in order to modify the latter. By depressing "Eschap" which is active only before you select and output number, it is possible to return to the learning menu.

Choice 2: Programm construction/up-dating

| PROGRAM CONSTRUCTION/UP-DATING |
|---|

| | AVAILABLE COMMANDS | |
|---|---|---|
| COMMAND: | I: INSERT<br>M: MODIFY<br>S: DELETE | <— PREVIOUS STEP<br>—> NEXT STEP<br>ESC END |
| | POSSIBLE MOVEMENTS | |
| COMMAND: | B: BASE<br>C: ELBOW<br>D: WRIST 1<br>E: SHOULDER<br>F: WRIST 2<br>G: CONNECTION | I: INPUTS<br>P: GRIPPER<br>S: OUTPUTS<br>T: TIMING<br>V: SIMUL.MOVEMENTS |

This module can be used:
- to produce a program by means of codes, skipping the teaching stage;
- to modify an existing program;
- to use the inputs with the conditioned connections.

You can choose 6 options:

I : inserting a new program after the current step.
M : modifying the value of a current movement.
S : eliminating the current movement.
<— : visualization of the previous movement.
—> : visualization of the next movement.
Esc : return to main menu ("Eschap").
The first window shows the information concerning the current step, the nature and the value of the movement.

Remark: if there is no program in the memory, the computer will wait for the entry of a new movement.

In this entire section, every movment is denoted by a letter:
B: BASE
C: ELBOW
D: WRIST 1
E: SHOULDER
F: WRIST 2
P: GRIPPER
V: SIMULTANEOUS MOVEMENTS
S: OUTPUTS
I: INPUTS
G: CONNECTION TO PROGRAM STEP.

All these movements will be described in detail later on.

## Insertion command (I)

When you select the insertion command by depressing "I", the computer then waits to be told the nature of the movement (see the different movement codes). Depress the key corresponding to the movement and the relative information will be requested according to the formated described below:

| PROGRAM CONSTRUCTION/UP-DATING | | |
|---|---|---|
| | AVAILABLE COMMANDS | |
| COMMAND: 1<br>MOVEMENT :<br>VALUE : | I: INSERT<br>M: MODIFY<br>S: ELIMINATE | <— PREVIOUS STEP<br>—> NEXT STEP<br>ESC END |
| | POSSIBLE MOVEMENTS | |
| STEP: | B: BASE<br>C: ELBOW<br>D: WRIST 1<br>E: SHOULDER<br>F: WRIST 2<br>G: CONNECTION | I: INPUTS<br>P: GRIPPER<br>S: OUTPUTS<br>T: TIMING<br>V: SIMUL. MOVEMENTS |

If you select one of the B,E,C,D or F codes, the computer will inquire about the value of the movement in degrees. Enter the desired value through the keyboard, then depress "Enter" to confirm it. After that, if you want to, you can comment the movement with a clear text. Depress "Enter" to validate your data and visualize the movement produced together with the explanatory comment.

Remarks: - If you enter an angular value higher than the allowable one for the movement involved, the assigned value to the movement will the maximum one.
- Default values are nil (zero).
- Comments should be in the same form for all types of positioning.

| PROGRAM CONSTRUCTION/UP-DATING | | |
|---|---|---|
| | AVAILABLE COMMANDS | |
| COMMAND: I<br>MOVEMENT: P<br>STATUS (O/F): | I: INSERT<br>M: MODIFY<br>S: ELIMINATE | <— PREVIOUS STEP<br>—> NEXT STEP<br>ESC END |
| | POSSIBLE MOVEMENTS | |
| STEP: | B: BASE<br>C: ELBOW<br>D: WRIST 1<br>E: SHOULDER<br>F: WRIST 2<br>G: CONNECTION | I: INPUTS<br>P: GRIPPER<br>S: OUTPUTS<br>T: TIMING<br>V: SIMUL.MOVEMENTS |

You have selected P, the Gripper code. The computer will inquire about its status. You can answer O to open or F to close.

Remark: the default value corresponds to gripper closed.

| PROGRAM CONSTRUCTION/UP-DATING | | |
|---|---|---|
| | AVAILABLE COMMANDS | |
| COMMAND: I<br>MOVEMENT: V<br>BASE: | I: INSERT<br>M: MODIFY<br>S: ELIMINATE | <— PREVIOUS STEP<br>—> NEXT STEP<br>ESC END |
| | POSSIBLE MOVEMENTS | |
| STEP: | B: BASE<br>C: ELBOW<br>D: WRIST 1<br>E: SHOULDER<br>F: WRIST 2<br>G: CONNECTION | I: INPUTS<br>P: GRIPPER<br>S: OUTPUTS<br>T: TIMING<br>V: SIMUL.MOVEMENTS |

You have now selected V (simultaneous movements). The computer will inquire about (in this order): desired values of the movement of the base, the shoulder and the elbow. Confirm each entry by depressing "Enter".

| PROGRAM CONSTRUCTION/UP-DATING | | |
|---|---|---|
| | AVAILABLE COMMANDS | |
| COMMAND: I<br>MOVEMENT: T<br>VALUE: | I: INSERT<br>M: MODIFY<br>S: ELIMINATE | <— PREVIOUS STEP<br>—> NEXT STEP<br>ESC END |
| | POSSIBLE MOVEMENTS | |
| STEP: | B: BASE<br>C: ELBOW<br>D: WRIST 1<br>E: SHOULDER<br>F: WRIST 2<br>G: CONNECTION | I: INPUTS<br>P: GRIPPER<br>S: OUTPUTS<br>T: TIMING<br>V: SIMUL.MOVEMENTS |

You have selected T (timing). You must introduce the timing value in seconds and confirm by depressing "Enter".

Remark: the limit value for the timer is 36000 seconds.

| PROGRAM CONSTRUCTION/UP-DATING | | |
|---|---|---|
| | AVAILABLE COMMANDS | |
| COMMAND: I<br>MOVEMENT: P<br>OUTPUT 1 (0/1/X) : | I: INSERT<br>M: MODIFY<br>S: ELIMINATE | <— PREVIOUS STEP<br>—> NEXT STEP<br>ESC END |
| | POSSIBLE MOVEMENTS | |
| STEP: | B: BASE<br>C: ELBOW<br>D: WRIST 1<br>E: SHOULDER<br>F: WRIST 2<br>G: CONNECTION | I: INPUTS<br>P: GRIPPER<br>S: OUTPUTS<br>T: TIMING<br>V: SIMUL.MOVEMENTS |

You have selected movement S (output) and now you must indicate the value of each output. To the question "OUTPUT x (0/1/X): ", answer:

1 to activate the output
0 to disactivate the output
X the state of the outut is indifferent.

| PROGRAM CONSTRUCTION/UP-DATING | | |
|---|---|---|
| | AVAILABLE COMMANDS | |
| COMMAND: I<br>MOVEMENT: P<br>INPUT 1 (0/1/X): | I: INSERT<br>M: MODIFY<br>S: ELIMINATE | <— PREVIOUS STEP<br>—> NEXT STEP<br>ESC END |
| | POSSIBLE MOVEMENTS | |
| STEP: | B: BASE<br>C: ELBOW<br>D: WRIST 1<br>E: SHOULDER<br>F: WRIST 2<br>G: CONNECTION | I: INPUTS<br>P: GRIPPER<br>S: OUTPUTS<br>T: TIMING<br>V: SIMUL.MOVEMENTS |

You have selected movement I which is interpreted as follows:
if the input word is present, then jump to step n; if it is not, carry on program execution in sequence.

The question "INPUT x (0/1/X)" admits three possible answers:

0: the input must not be valid
1: the input must be valid
X the input value is indifferent.

For each input, answer 0, 1 or X depending on the desired value. Then the computer inquires: "STEP No. :" ? instead of "INPUT x (0/1/X):" and you must enter the number of the stp to be executed if the input condition is valid. Then confirm your choice by depressing "Enter".

Remarks: - this movement is not available in the learning sesstion;
- if you answer the question "INPUT x (0/1/X):" by depressing "Enter", default input values will be different.

| PROGRAM CONSTRUCTION/UP-DATING | | |
|---|---|---|
| | AVAILABLE COMMANDS | |
| COMMAND: I<br>MOVEMENT: P<br>STEP No.: | I: INSERT<br>M: MODIFY<br>S: ELIMINATE | <— PREVIOUS STEP<br>—> NEXT STEP<br>ESC END |
| | POSSIBLE MOVEMENTS | |
| STEP: | B: BASE<br>C: ELBOW<br>D: WRIST 1<br>E: SHOULDER<br>F: WRIST 2<br>G: CONNECTION | I: INPUTS<br>P: GRIPPER<br>S: OUTPUTS<br>T: TIMING<br>V: SIMUL.MOVEMENTS |

You have selected G (unconditional connection). When the instruction is executed, it will entail a systematic connection to the step No. indicated.

| PROGRAM CONSTRUCTION/UP-DATING | | |
|---|---|---|
| BASE: 30<br>Base movement : 30° | | |
| | AVAILABLE COMMANDS | |
| COMMAND: M<br>VALUE: | I: INSERT<br>M: MODIFY<br>S: ELIMINATE | <— PREVIOUS STEP<br>—> NEXT STEP<br>ESC END |
| | POSSIBLE MOVEMENTS | |
| STEP: 2 | B: BASE<br>C: ELBOW<br>D: WRIST 1<br>E: SHOULDER<br>F: WRIST 2<br>G: CONNECTION | I: INPUTS<br>P: GRIPPER<br>S: OUTPUTS<br>T: TIMING<br>V: SIMUL.MOVEMENTS |

You have selected a command which modified the value of a movement. Depending on the type of movement of the current step, the computer asks you to introduce the new value, as described in the preceding pages.

| PROGRAM CONSTRUCTION/UP-DATING | | |
|---|---|---|
| ELBOW : 15<br>ELBOW MOVEMENT BY 15° | | |
| | AVAILABLE COMMANDS | |
| COMMAND: S<br>VALIDATION (O/N): | I: INSERT<br>M: MODIFY<br>S: ELIMINATE | <— PREVIOUS STEP<br>—> NEXT STEP<br>ESC END |
| | POSSIBLE MOVEMENTS | |
| STEP: 205 | B: BASE<br>C: ELBOW<br>D: WRIST 1<br>E: SHOULDER<br>F: WRIST 2<br>G: CONNECTION | I: INPUTS<br>P: GRIPPER<br>S: OUTPUTS<br>T: TIMING<br>V: SIMUL.MOVEMENTS |

You have selected to eliminate a step in the program (Command S). Confirm your request be depressing "O" (letter O) to continue with the elimination of "N" to disactivate the command.

In both cases, return to the command menu.

Slider keys enable you to:
- shift to the left: visualize the previous step
- shift to the right: visualize the next step

Remarks:
- if you reach the program step limits, the visualization will be about these limit steps.
- thanks to these two commands, you can use the comands I (insertion, M (modification) and S (elimination) on any program step.
- a non coded visualization of each instruction is shown in the first window depending on the type of movement requested.

Choice 3: Execution of a program

| PROGRAM EXECUTION |
|---|
| 1 TOTAL EXECUTION<br>2 STEP BY STEP EXECUTION |
| YOUR CHOICE: |

This module enables you to execute your program.

You are offered two options:

1 total execution
2 step by step execution

Total execution: the program is performed without stopping between the subsequenct steps.
Step by step execution: after executing each step, the computer waits until you depress the key before going on to the next.

| PROGRAM EXECUTION |
|---|
| 1 TOTAL EXECUTION<br>2 STEP BY STEP EXECUTION<br><br>No. OF REPETITIONS |
| YOUR CHOICE: 1 |

Then the computer will ask how many time you want the cycle to be repeated. Answer the question and confer your answer by depressing "Enter".

Remark: - if the number of cycles is zero, your program will not be executed.

| EXECUTION UNDER WAY |
|---|
| BASE : 0 |
| STEP : 210 |

You have selected total execution.
During the execution, the computer shows the program step No. being treated, and the movement involved.

Remarks: you can cancel program execution at any time by depressing "Eschap" (Escape).

| EXECUTION UNDER WAY |
| --- |
| BASE : 0<br><br>DEPRESS A KEY |
| STEP : 210 |

You have requested a step by step execution.
Between two instructions, the computer tells you to depress a key to make it go on.

Remark: as was the case with total execution, the program can be cancelled by depressing "Eschap".

Choice 4: Reading of program on magnetic disk

This module enables you to read a previously saved program from a magnetic disk and to load it into the memory. Introduce the name of the program involved, possibly preceded by the name of the disk unit (A: . . . . C:), then depress "Enter" to confirm.

Caution: - The name of the program must be introduced without extension.
- If a program was already in the memory, it would be destroyed by the new one. However, if some editing has been done on the program in store, the computer will ask you if you want to save it on a disk by means of the save module of option 5.
- If you confirm without entering the name of a file you will return to the main menu.

## Choice 5: Saving the program

This module enables you to save the program which is currently in the memory onto a magnetic disk. Introduce the name of the program without indicating any extension, if necessary preceded by the name of the disk unit (A: . . . . C:), then confirm by depressing "ENTER".

Remarks: - if the name of the program already exists on a disk, the computer will inquire whether you to to destroy the old program and replace it with the new one. If you say no, the computer will ask you to provide a name for the new program.
- if you confirm without giving a name, you will return to the main menu.

## Choice 6: Catalogue

This module enables you to visualise all the programs that have been saved on a disk.
Introduce the letter corresponding to the disk reader where the programs are located.

## Choice 7: Program Listing

| LISTING |
| --- |
| 1 SCREEN LISTING<br>2 PRINTER LISTING<br>ESC RETURN TO PREVIOUS MENU |
| YOUR CHOICE : |

With this module the program in the memory can be listed, on the screen or as a rpint out.

The layout will be as follows:

"number of the step  letter denoting the command  movement comment"

If you choose the printer, the screen will read:

"PROGRAM LISTING
CHECK WHETHER THE PRINTER IS READY
THEN PRESS A KEY TO CONTINUE".

At this point, press a key to get the printing started.

Remark: by pressing "Eschap" you can return to printing menu without using the printer.

Choice 8: Flexible cell interface

| FLEXIBLE CELL INTERFACE |
|---|
| 1 SCREEN LISTING<br>2 PRINTER LISTING<br>3 SAVING IN THE FLEXIBLE CELL FORMAT<br><br>ESC RETURN TO PREVIOUS MENU |
| YOUR CHOICE : |

This module makes it possible to transform the program in the memory into a program for use in a flexible workshop environment (robots, conveyors).
When transformed, the program will no longer take into account the input and output conditions, and all unconditional connections will be ignored.
You can visualise this program on the screen by depressing key "2" or save it on a disk by pressing "3".

Key "Eschap" enables you to return to the main menu.

Choice 9 - Resetting the working memory

This module enables the contents of the working memory to be started so that you can produce a new program.
Confirm your choice by pressing key "0" or cancel it with "N" which makes you go back to the main menu without emptying the working memory.

Choice 0 - Exit towards DOS

This choice concludes your work and you retunr to the command level of the management system.