

INTRODUCTION TO PLC

Laboratory Exercises

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Code No. BOK 320030

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PLC Logic

Introduction

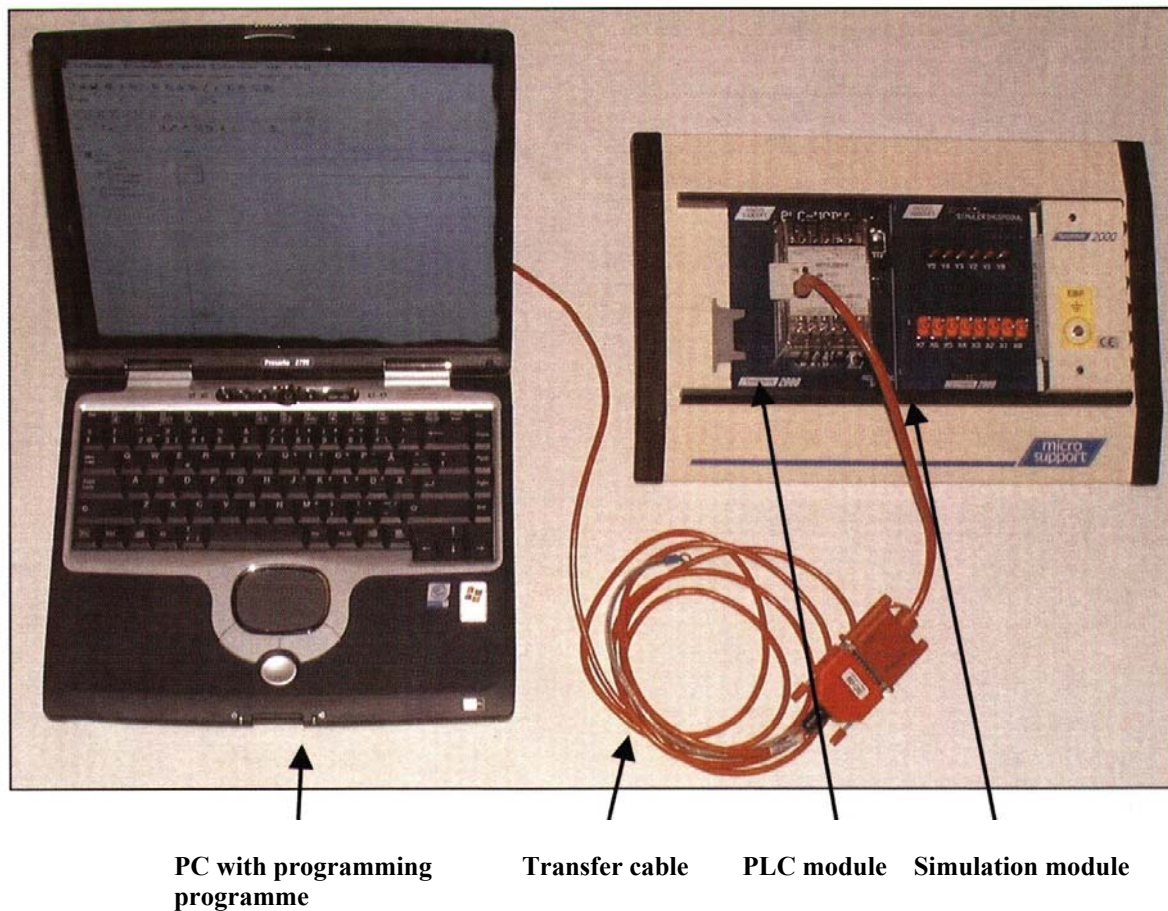
In this first chapter the objective is to be acquainted with how a control system (PLC) can be used to complete the logic functions and holding control circuits that are required in control techniques. A control programme will be created for these functions with the help of a programming programme in the PC and then to transfer the control program over to the PLC.

The control system will be supplied by a 24V DC voltage from the Base Unit 2000. A simulation module shall then be connected to the control system with switches that are mounted on the PLC module.

See the figure below.

Equipment

PLC module
Simulation module
Base Unit 2000
PC computer with
programming programme
Transfer cables



Experiment 1: Assembly and connection of the PLC

Aims of the Experiment

To set up a control system which will help to prove the programming of logic functions.

Equipment

PLC module
Simulation module
Base Unit 2000
PC computer with programming programme
Transfer cable SC-09

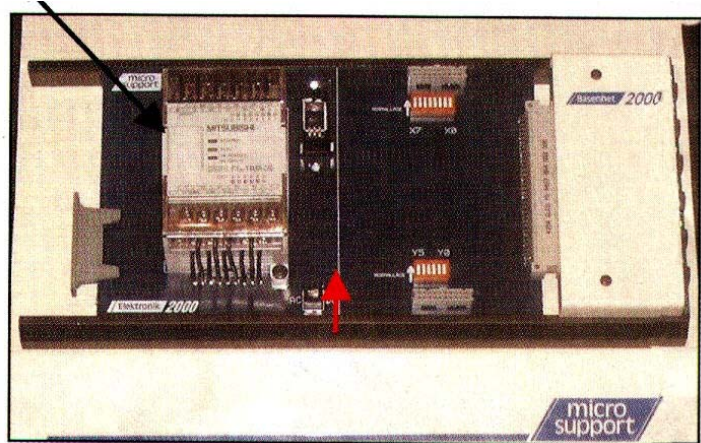
The PLC Module

The experiments in control techniques are carried out using the PLC module. On the PLC module there are connection terminals for simulation, traffic and plinth modules. During the experiments they shall be in the “**Normal position**”.

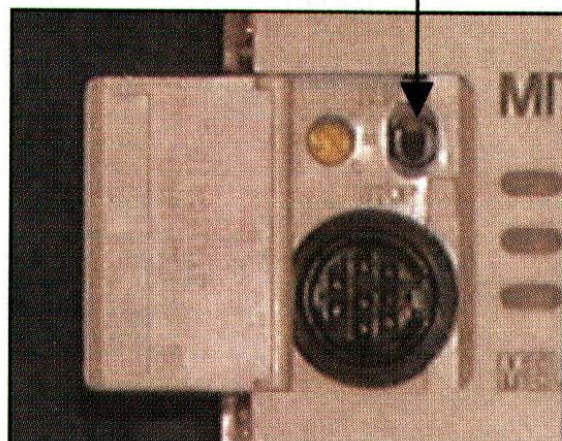
The switch AC-DC (red arrow) shall be in the DC position.

Opening for communications port

1. Take up the equipment as shown in the list above and assemble the PLC module on the Base Unit 2000.
2. Connect the simulation module to the connection terminals on the PLC module. See the figure on the previous page.
3. Open the small opening for the communication port on the left side of the PLC and find the RUN/STOP switch.
4. Connect the transfer cable SC-09 into the two 25 pole d-sub contacts.

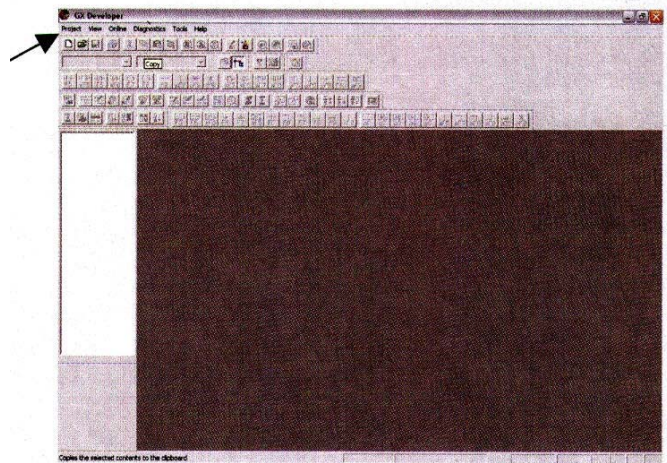


RUN/STOP switch



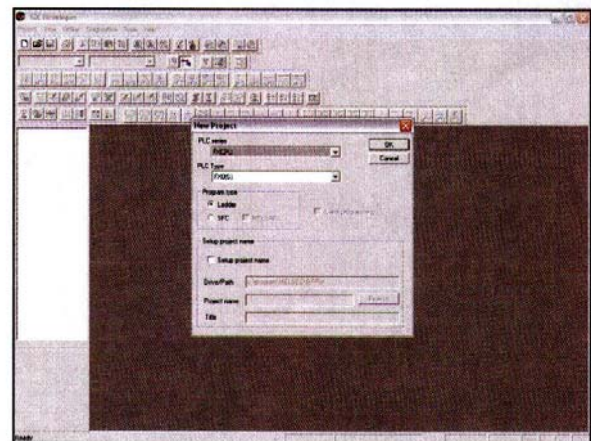
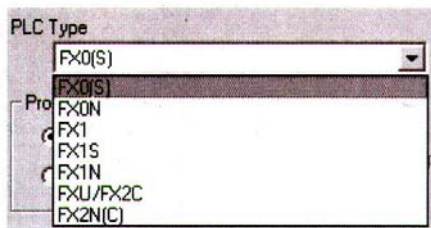
Communications port

- 5 Take the small round (mini din) contact and set it into the communications port in the PLC. Avoid turning the contact as the pins can be damaged.
- 6 Connect the 9-pole d-sub contact into the other end of SC-09 to the serial port (com) on the PC.
- 7 Start the PC and the programming programme that is to be used, e.g. GX developer. This programme can be found in file Melsoft Application in the start menu.
- 8 The project window to the right now opens.
- 9 Click on **project** then down to **New Project**. Select by a single click.
- 10 Select PLC



Select by clicking on the arrow at **PLC series:** FXCPU.

Select by clicking on the arrow in the window at **PLC Type:** FXO (S) (or that which is printed on the computer being used)

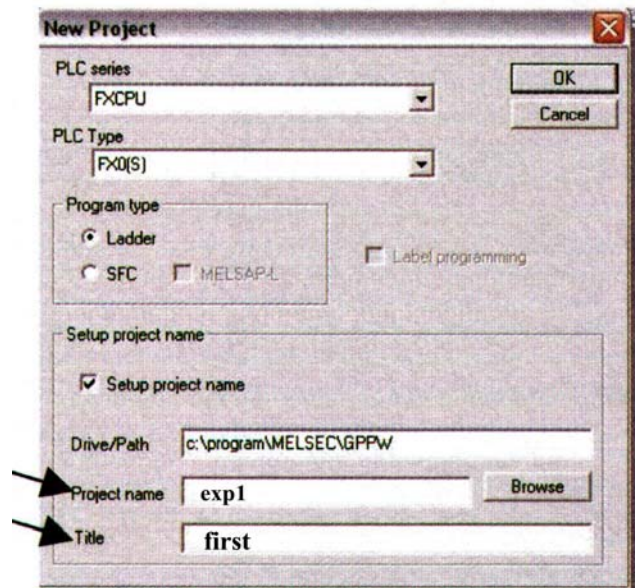


11 With the mouse click on program type “**Ladder**” and the programming programme is ready with the relay stage.

12 Click then in the window “**set-up project name**” and fill in the two lower sections as shown in the figure to the right. As this is Experiment 1 it is appropriate to name it exp1. The project can be named “first”.

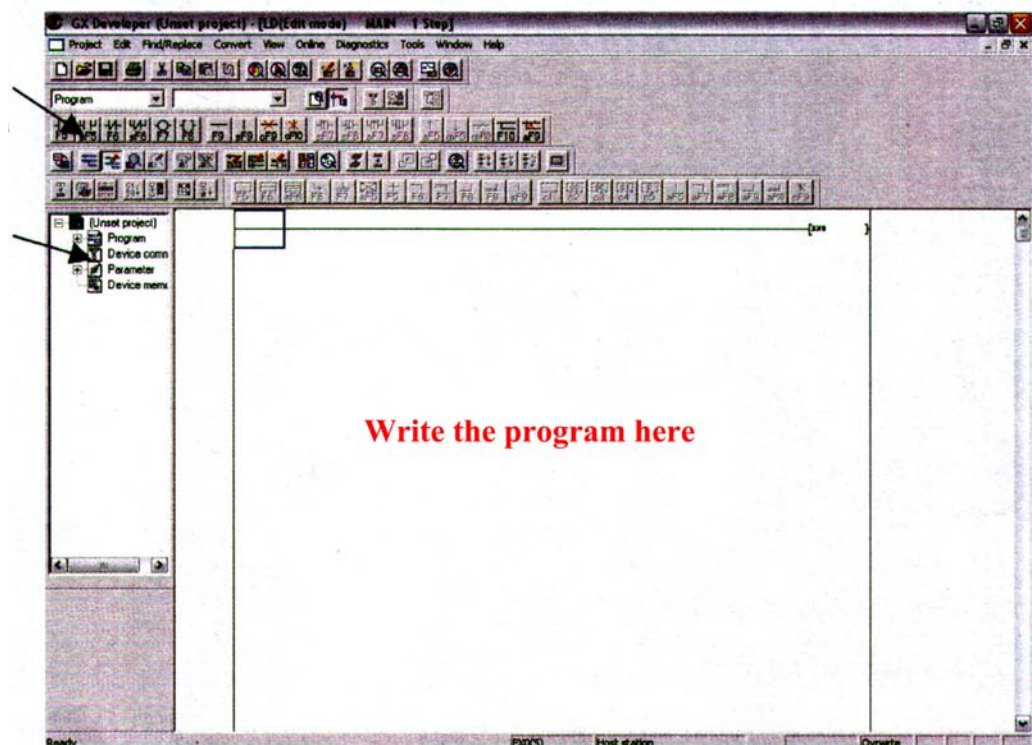
13 Click **OK** and answer “yes” when asked to start a catalogue.

14 Now the control system is connected and a project for writing the programme has been opened.
The project should be similar to that shown below.



Contacts and coils are called programme elements

Project parts



The scene is now set for programming in Ladder. Later in the experiment a closer look will be made at instruction lists or function diagrams.

Continue with experiment 2 where the control system will be informed on how the in- and outputs shall function.

Experiment 2: Inputs and outputs – a programme

Aims of the Experiment

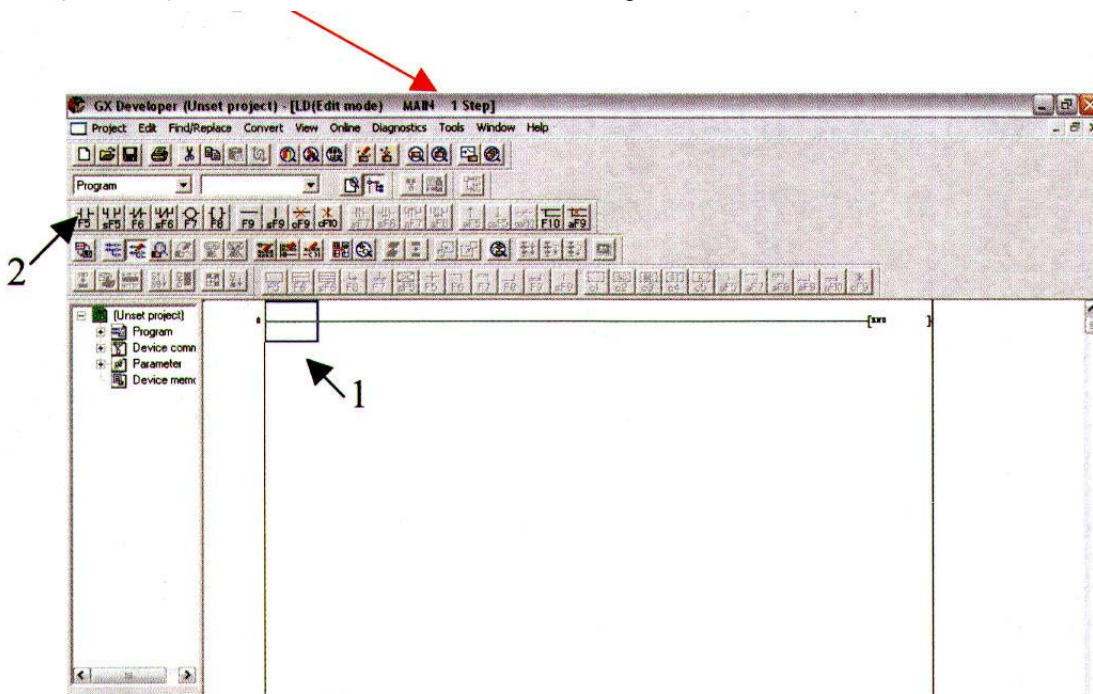
To program a “yes” function and then transfer the programme to the PLC. To start the PLC and test the function.

Equipment

PLC module
Simulation module
Base Unit 2000
PC computer with
programming programme
Transfer cable SC-09

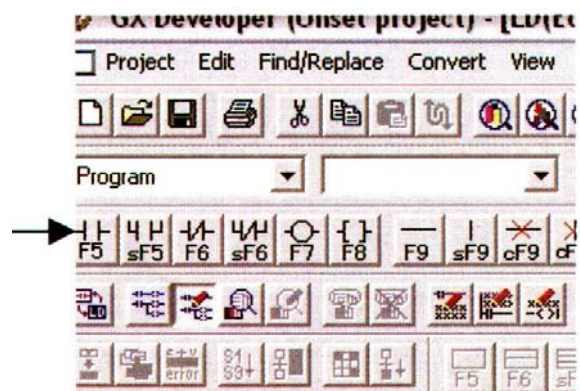
The next task is to write a program that will give a “Yes” function; a logic input signal is sent to an output

Take up the programming programme used in the previous experiment. Check that LD (edit mode) is displayed in the top window (red arrow).
If it is in read mode, press F2.

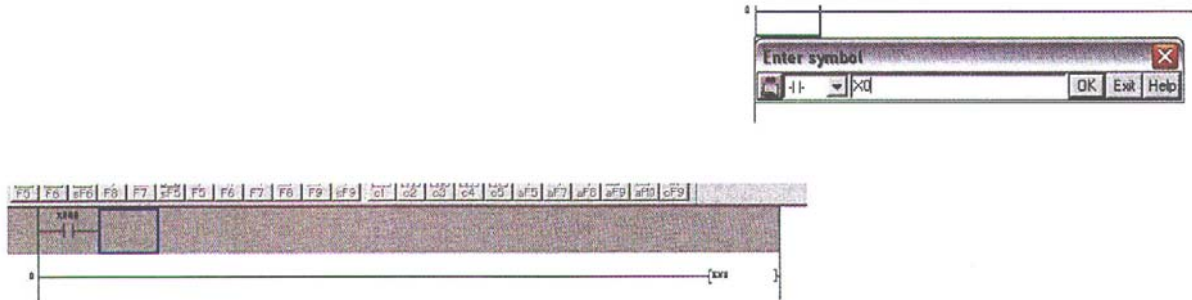


1 Click the mouse on the blue frame.

2 Click on the contact among the programme elements or press F5 to take up the frame “enter symbol” into which it is possible to write which of the control system inputs shall be used. Write in the control systems first input :X0 (*Note: number 0 and not the letter O*).

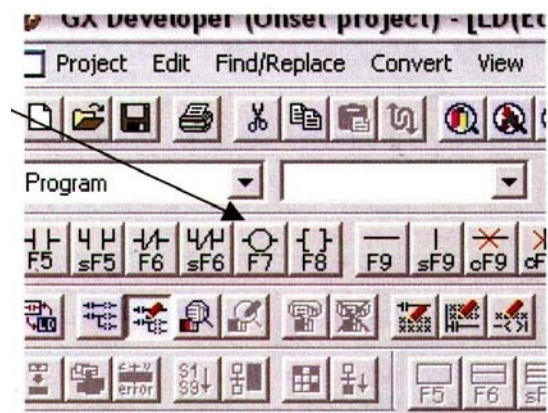


- 3 Click on **OK** or press enter and a closed contact with the title of X000 will appear in its own row in the ladder

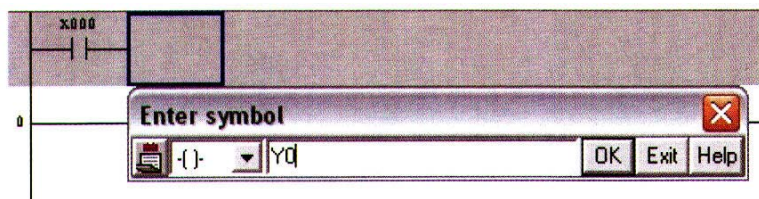


Closed contact X000 as seen on the screen

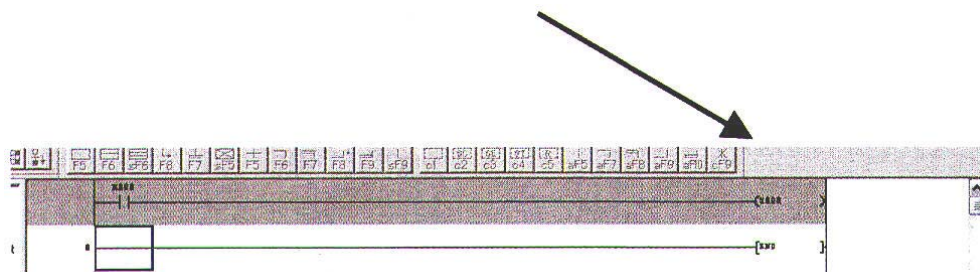
- 4 This input will now be connected to one of the control systems outputs. Select “coil” from the program elements and click on the symbol or press F7. This will be used to control output (Y).



- 5 A window with “enter symbol” should now be seen on the screen. In this space write in which of the control systems outputs shall be used. Write in the control systems first output: Y0 (Note: Number 0 not letter O).



- 6 Click **OK** or press enter. An output with the title Y000 now appears in the ladder diagram.

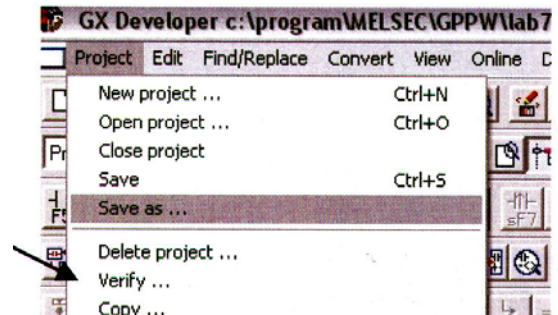


A simple programme has now been created by writing on the screen in a programming programme for PLC. The project must now be saved before transferring the programme to the control system.

- 7 Before saving and transfer of the programme to the PLC, it must be translated into instructional code that the control system can understand. This is completed by the function **Convert** in the menu.

Convert to instructional code

- 8 Open the menu “**project**” and click on “**Save as**”.



- 9 Write the project name: exp2 and title- second. See figure under. Answer “**Yes**” to the question if a new project shall be created.

Drive/Path	c:\program\MELSEC\GPPW\
Project name	exp2
Title	second

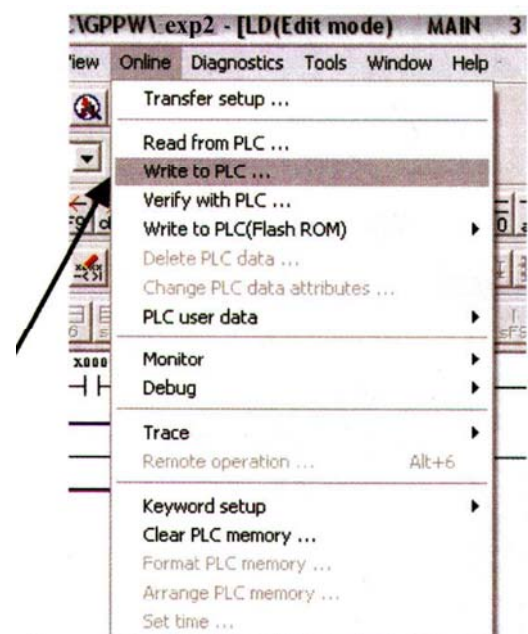
Programme transfer

The programme is now saved in the correct form for the control system. Test to see if it functions, as it should. Transfer!

Preparation

- Check that the transfer cable SC-09 is connected between the PC and the PLC as shown in experiment 1.
- Energise the Base Unit so that the **POWER** LED lights up on the PLC.
- Check that the communications port switch is in the **STOP** position.

- 1 Open the Online menu and click on **Write to PLC**.

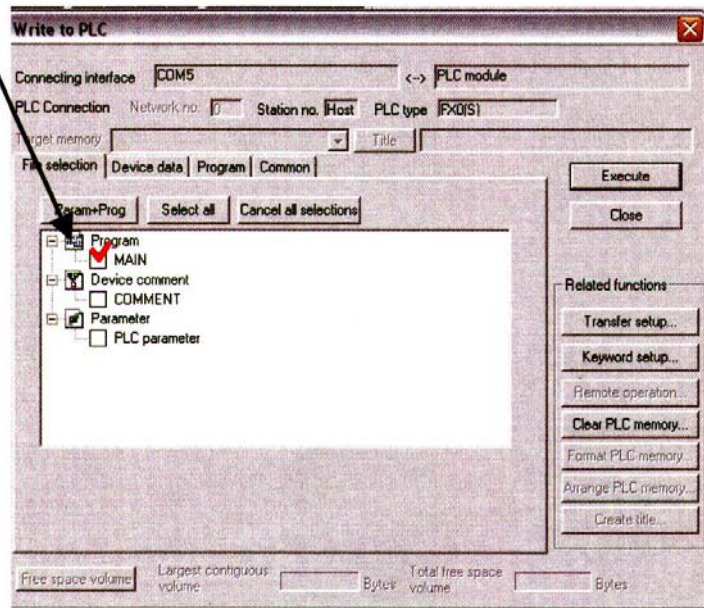


Remember that the programme is written in a window called **Main**.

- 2 This programme shall now be transferred to the PLC.
Mark the box named **MAIN** and click on the mouse.

- 3 Complete the transfer by clicking on **Execute**.
Answer “Yes”.

- 4 The transfer is completed when GX Developer informs that the transfer has been completed.
Accept this by clicking on **OK**.



If it does not function :

- Check that the PLC is in the **STOP** position.
- Check that the Base Unit is switched on.
- Check that the lead SC-09 is connected at both ends.
- Check that the box marked **MAIN** has been selected.
- Try once again.

If it still does not function, call the teacher.

Test run of the programme

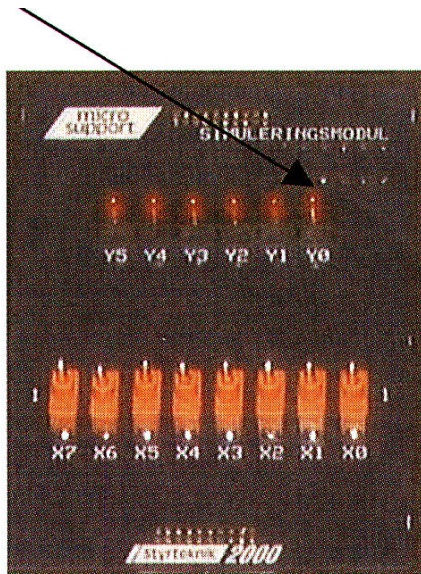
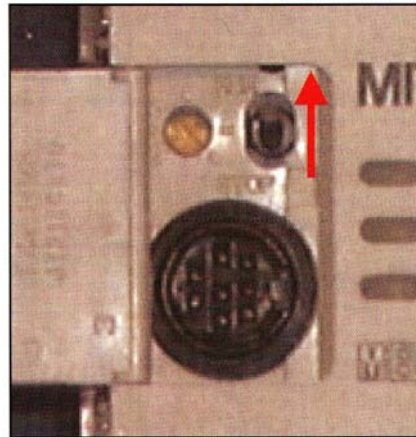
The programme should now be in the control systems memory. Now test to see if it functions.

Set all the switches on the simulation module to the **down** position.

Carefully switch on the small RUN/STOP switch on the PLC to the **RUN** position. The programme should start.

Activate the input X0 on the PLC by putting the switch that is furthest to the right, on the simulation module, to the **ON** position.

The LED Y0 on the right should be lit when X0 is activated.



Task 2a

Complete the truth table whilst testing the programme in the PLC.

If the experiment does not function:

- Check that the PLC is in the **RUN** position.
- Check that the Base Unit is switched on.
- Check that the input diode IN 0 on the PLC lights up when switch X0 is switched ON.
- Check that the green, RUN lamp on the PLC is lit.
- Try once again.

X0	Y0
0	
1	

Experiment 3: Logic

Aims of the Experiment

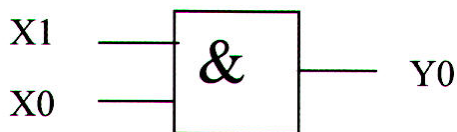
To program a few basic logic functions that will be transferred to the PLC. Start up the PLC and test the functions.

Equipment

PLC module
Simulation module
Base Unit 2000
PC computer with
programming programme
Transfer cable SC-09

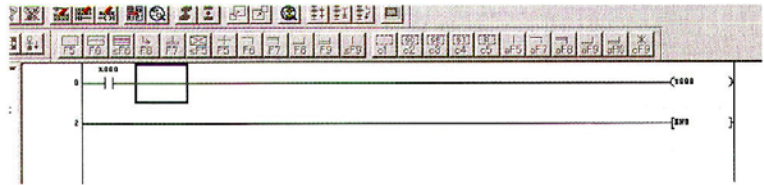
An extension to the previous experiment will be made by adding a programme element for the normally closed contact, this will give an AND function between inputs X0 and X1. The result of this logic operation will control the output Y0.

Compare with the logic symbols below.

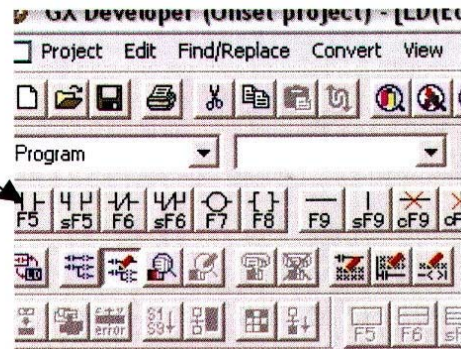


- Open the previous experiment on the PC screen.
- Check that the programming programme is in the “edit mode” so that the new control programme can be written.
- The screen display should now read **(LD (edit mode) MAIN 3 Step)** highest up on the programming window of the PC.

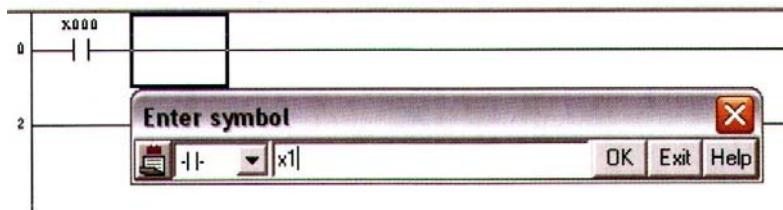
- 1 Click with the mouse to the right of X000 on the screen so that a blue square appears as shown on the right.



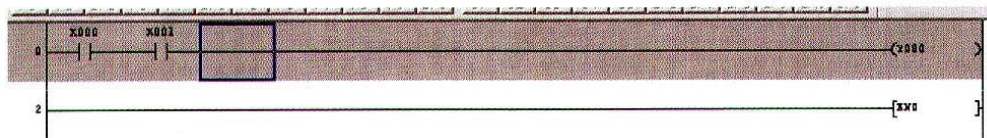
- 2 Click on a normally closed contact from the programme elements or press F5 so that the "enter symbol" box appears. Here it is possible to write in which of the control systems inputs shall be used.



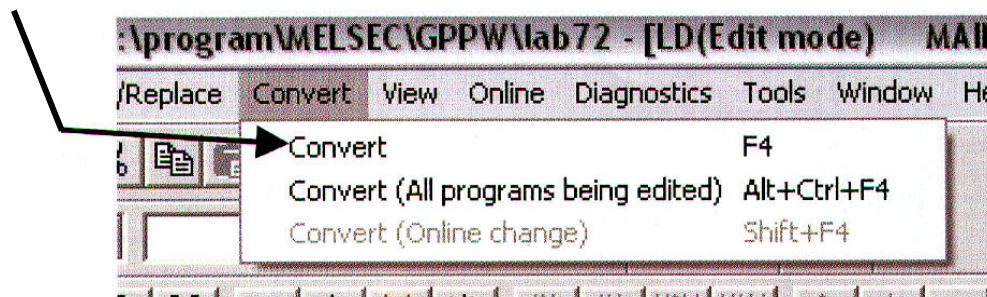
- 3 Write in the control systems second input X1.



- 4 Click **OK** or press enter. A normally closed contact with the title X001 has now been added with its own row in the ladder diagram.

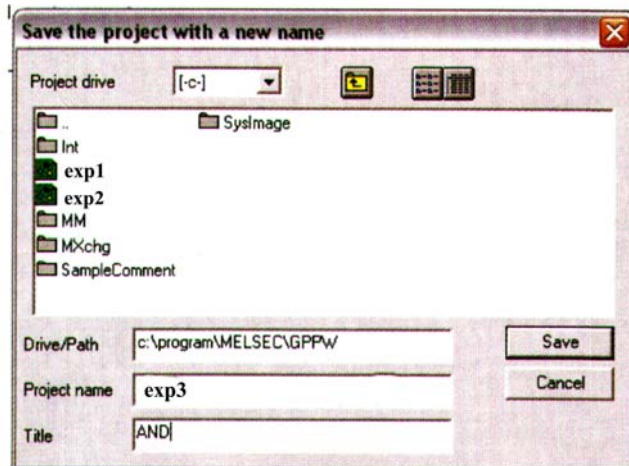
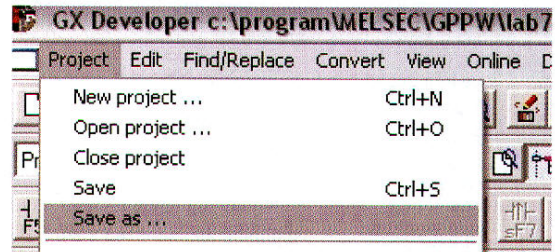


- 5 Before saving and transferring the programme that has now been written in the ladder diagram, it must first be translated to PLC instructions using the function "Convert" in the menu.



- 6 Go to the menu “**Project**” and select “**Save as**”.

- 7 Write in **exp3** as project name and **AND** as title.



- 8 Click on “**Save**” and answer “**Yes**” to the question, new project?
- 9 Continue with the transfer of the control programme from the PC to the control systems memory below.

Now test and see if the PLC programme functions properly.

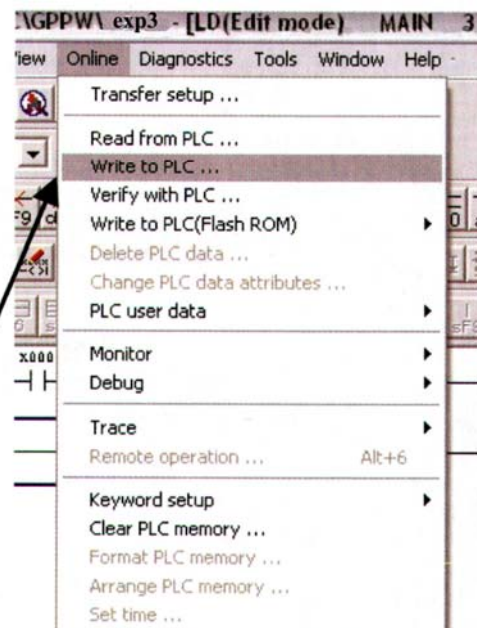
Programme transfer

The programme is now saved in the correct form for the control system. Test to see if it functions, as it should. Transfer!

Preparation

- Check that the transfer cable SC-09 is connected between the PC and the PLC as shown in experiment 1.
- Energise the Base Unit so that the **POWER** LED lights up on the PLC.
- Check that the communications port switch is in the **STOP** position.

- 1 Open the Online menu and click on **Write to PLC**.



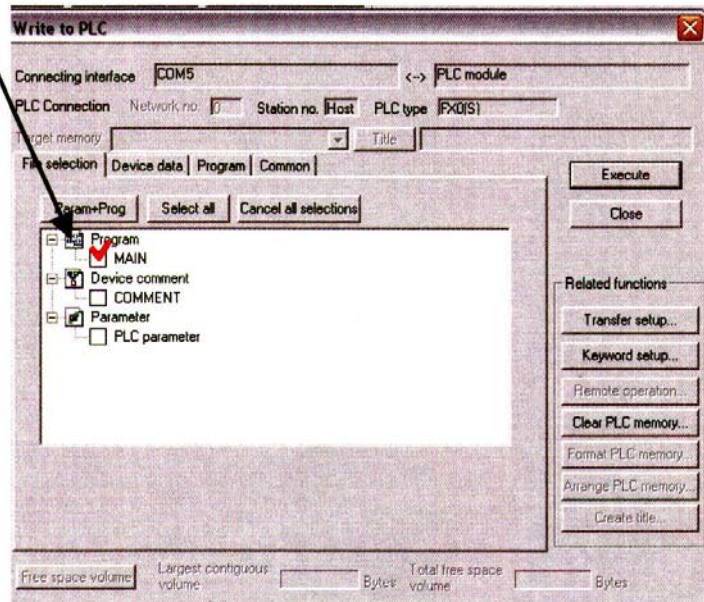
Remember that the programme is written in a window called **MAIN**.

- 2 This programme shall now be transferred to the PLC.

Mark the box named **MAIN** and click on the mouse.

- 3 The transfer is completed when GX Developer informs that the transfer has been completed. Accept this by clicking on **OK**.

- 4 The transfer is completed when GX Developer informs that the transfer has been completed. Accept this by clicking on **OK**



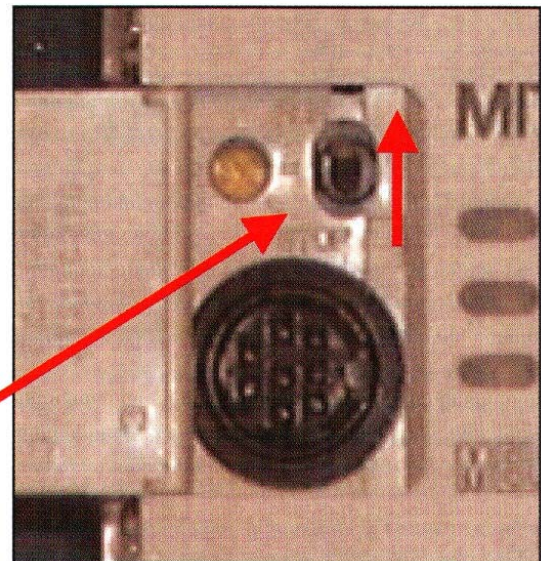
Test run of the programme

The programme should now be in the control systems memory. Now test to see if it functions.

Set all the switches on the simulation module to the **down** position.

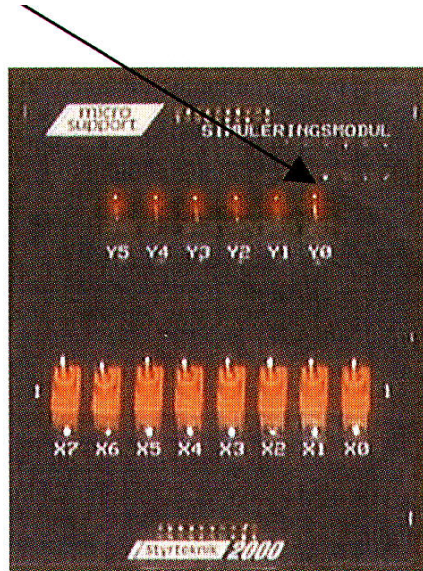
Carefully switch on the small RUN/STOP switch on the PLC to the **RUN** position. The programme preparation should start.

Activate the input X0 on the PLC by putting the switch that is furthest to the right, on the simulation module, to the **ON** position. Nothing should happen!



Now activate input X1 on the PLC by switching on X1 to the right on the simulation module. Output Y0 should now indicate on the control system and on the simulation module.

The LED Y0 on the right should be lit when X0 and X1 are activated.



Task 3a

Complete the truth table whilst testing the programme in the PLC.

If the experiment does not function:

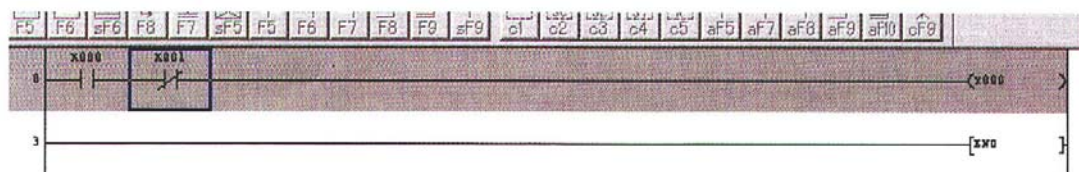
- Check that the PLC is in the **RUN** position.
- Check that the Base Unit is switched on.
- Check that the input diode IN 0 on the PLC lights up when switch X0 is switched **ON**.
- Check that the green, **RUN** lamp on the PLC is lit.
- Try once again.

X0	X1	Y0
0	0	
0	1	
1	0	
1	1	

If it still does not function, call the teacher.

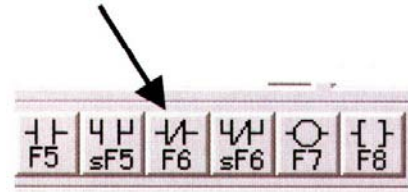
Task 3b

Change the programme so that it looks like the figure below.



Make sure that the PC shows “edit mode” so that it is possible to change the programme.

- 1 Select **X001** and click on an opening contact in the programme elements.



- 2 Write **X1** in the window that opens and click **OK**.

- Convert the programme.
- Save the project (e.g. as **exp3b**, title **ANDNOT**)
- Transfer the programme to the PLC (make sure that the PLC is in the **STOP** position)
- Test run by starting the PLC and switching on the switches that are connected to the control systems inputs X0 and X1. See table below.

- 3 Complete the truth table whilst testing the PLC programme.

X0	X1	Y0
0	0	
0	1	
1	0	
1	1	

- 4 Complete the logic symbol diagram for the logic function that has been proven!



Experiment 4: Logic OR

Aims of the Experiment

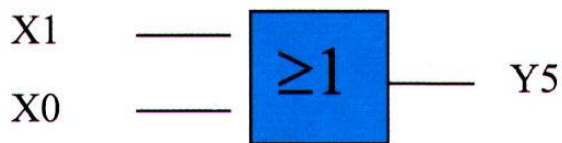
To create a project for programming an OR function. The programme shall be transferred to the PLC. To start the PLC and test the function.

Equipment

PLC module
Simulation module
Base Unit 2000
PC computer with programming programme
Transfer cable SC-09

A completely new project will be created. A circuit will be built up in the form of a ladder diagram, including two programme elements for closing contacts, to make an OR function between X0 and X1. The resultant logic operation will control output Y5.

Compare with the logic symbols below!



Create a new project

1 Start the PLC and the programming programme.

2 Select “**Project**” and “**New project**”!
From the menu.

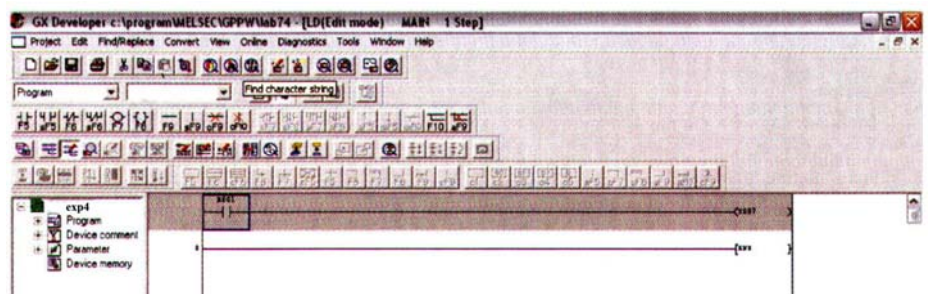
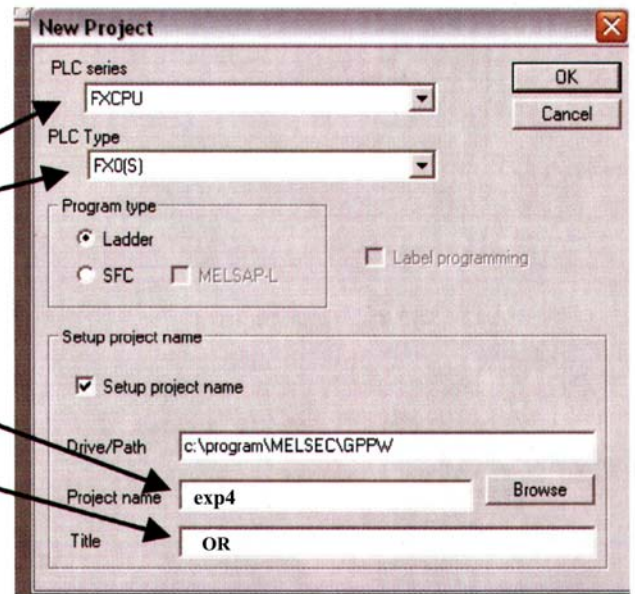
3 Write in the correct PLC series and type.

4 Write in the project name: **exp4**

5 Write in the project title: **OR**

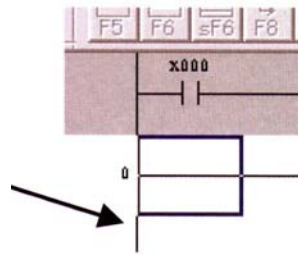
6 Click OK

7 First program a circuit as shown below. This connects input X0 to output Y5.

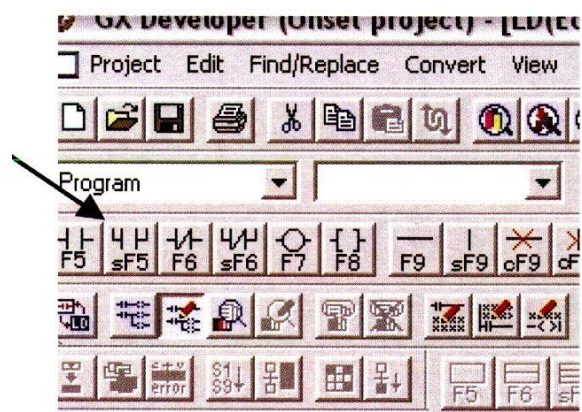


Place input X1 parallel with X0 as follows:

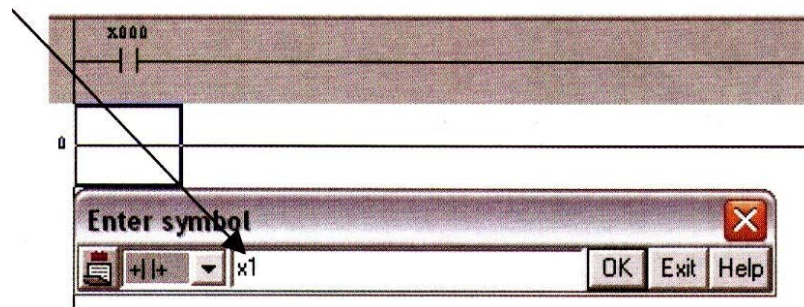
- 8 Place the marker under contact X000 so that a blue square appears under contact X000.



- 9 Collect a parallel connected closing contact from the programme elements.

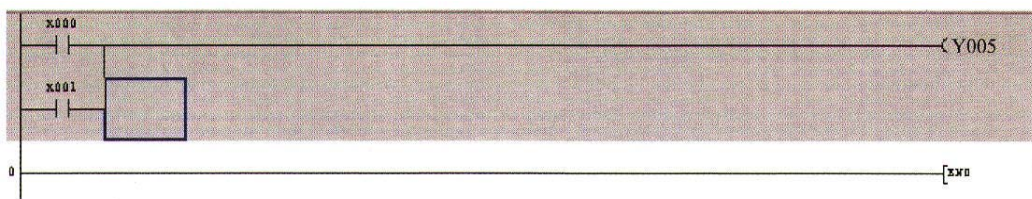


- 10 Write in that the contact shall be input X1



- 11 Click **OK**.

The completed programme constructed from a ladder diagram should be similar to the figure below.



- Convert the programme
- Save the project
- Transfer the programme to the PLC (make sure that the PLC is in the STOP position)
- Test run by starting the PLC with X0 or X1.

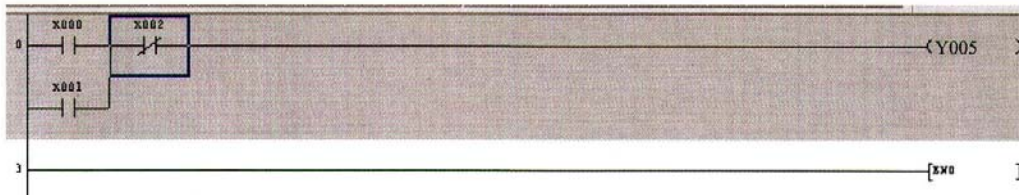
Task 4a

Complete the truth table whilst testing the programme in the PLC.

X0	X1	Y5
0	0	
0	1	
1	0	
1	1	

Task 4b

Change the programme in experiment 4 so that the function is as the ladder diagram below.



- Convert and transfer the programme to the PLC (make sure that the PLC is in the stop position).
- Save the project (e.g. project name exp4b, title ANDNOTX2).
- Test run by starting the PLC and switching on the switches that are connected to the control systems inputs X0, X1 and X2, as shown in the truth table below.

Complete the truth table whilst testing the programme in the PLC.

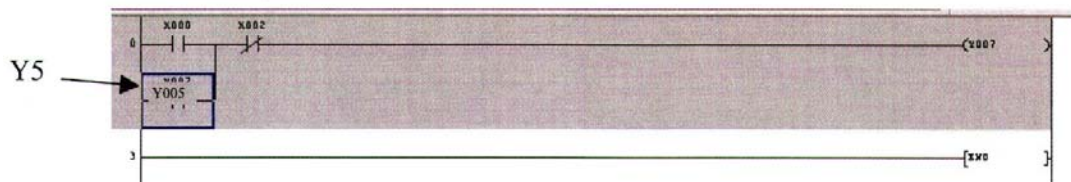
Write the connection between X0, X1, X2 and Y5 in the form of a logic expression.

Y5=

X0	X1	X2	Y5
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

Task 4c

Change X1 in the programme in experiment 4 so that the function is as the ladder diagram below.



- Convert the programme (Use Convert in the menu).
- Save the project (e.g. project name-exp4c, title- hold).
- Transfer the programme to the PLC (make sure that the PLC is in the stop position).
- Set all the switches in the down (off) position.
- Check the function of the programme by starting the PLC and switching on the switches that are connected to the control systems inputs X0, X1, as follows:

- 1 Set the switch that is connected to input X0 to the **ON** position.
- 2 Switch OFF.

What happened to Y5?

- 3 Switch ON the switch that is connected to X1.
- 4 Switch OFF.

What happened to Y5?

How is it possible to switch on Y5 again?

Recall the function from the experiments with the relay.

A hold circuit has been programmed in the PLC. With one or more hold circuits it is possible to programme the control of an installation that works in sequence, i.e. first there is some form of action and when it is completed a signal is given for the next action to start, when it is completed a signal is given for the next action to start etc. etc. This function is very good when programming the traffic modules signals or selection installation with Autobuild junior.

Which input represents the start in the relay experiment giving a signal to Y5?

Inputis the start!

Which input represents the stop in the relay experiment giving a signal to Y5?

Inputis the stop!

