# 31343 Introduction to Programmable logic Controllers
# Exercise 3 : “ex3_plc_startup”

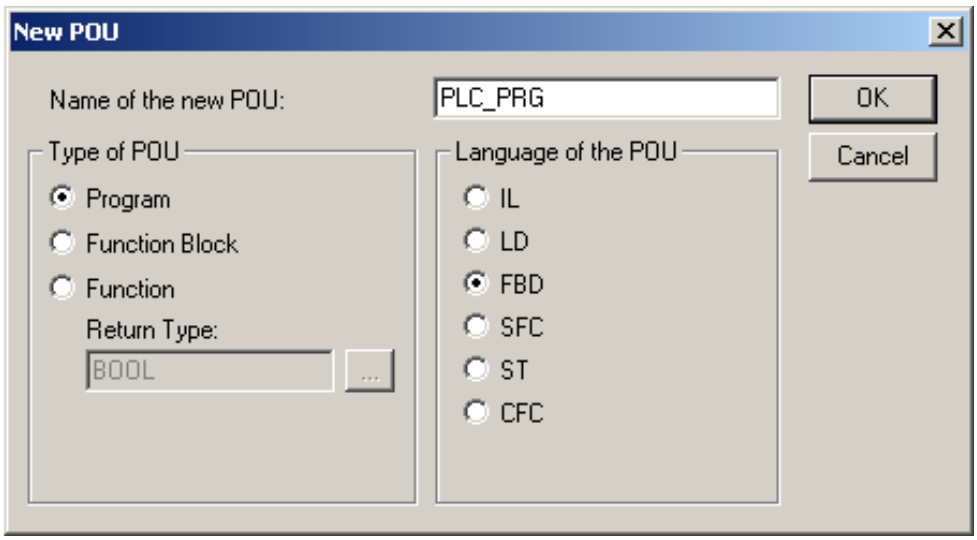
## PLC – Introduction

DTU-Elektro has a number of ABB Programmable Logic Controllers (PLCs) of the AC500 series. This exercise is going to introduce you to configuration and programming of these.

*ABB AC500 Distributed Automation Programmable Logic Controller.*

## Configuration

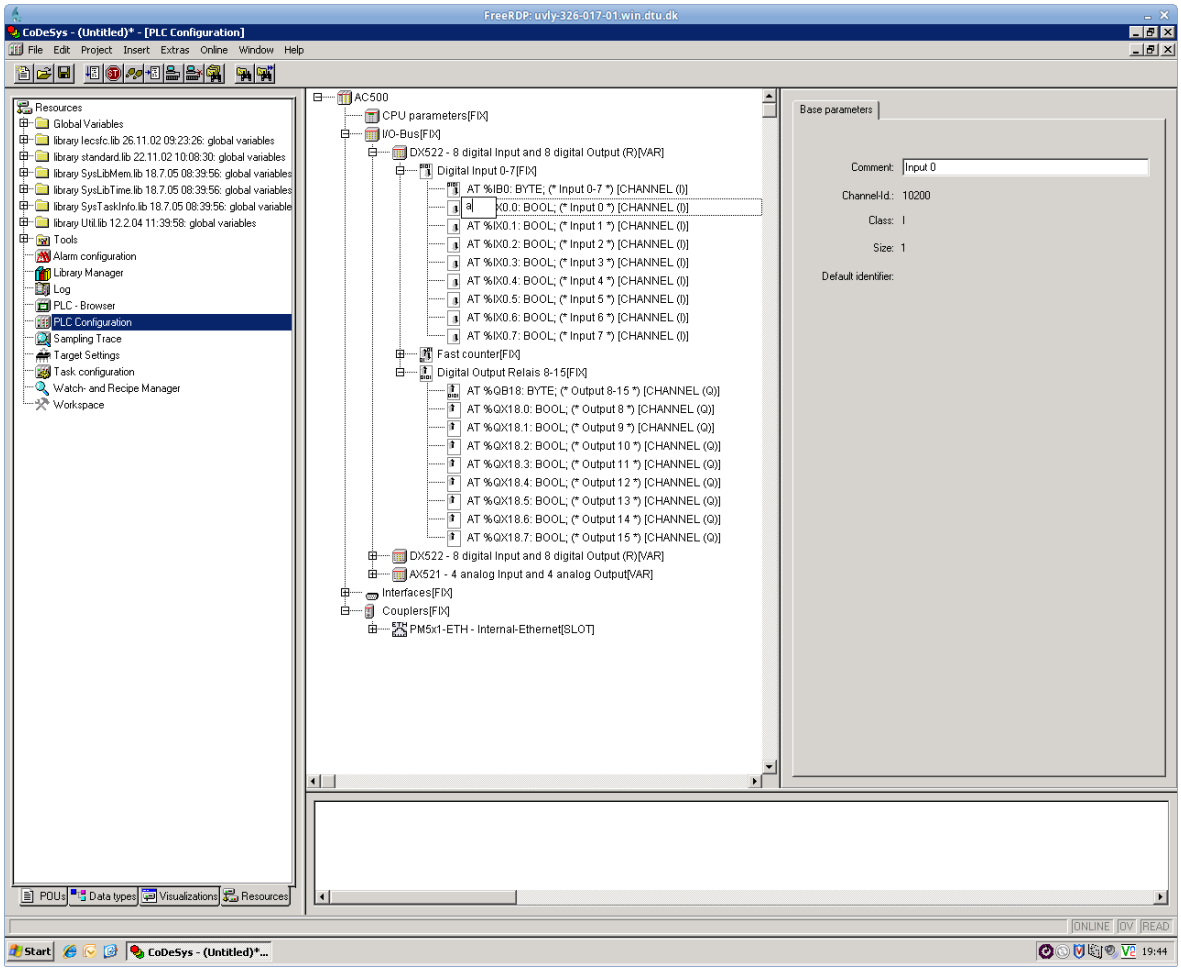
To start up the PLC plug in an ethernet cable into the RJ-45 connector. This cable should be connected to the AUT network (ask the teaching assistant where). Then plug in the power cable to switch on power and the PLC should wake up after a short initialisation period.
We use the programming environment called CoDeSys for programming the PLC. It is found by opening Windows Explorer and go to the folder with the path: c:\Program Files (x86)\3S Software\CoDeSys V2.3. Execute the application called CoDeSys in this folder. When CoDeSys is loaded up, create a new project by choosing File → New. In the pop-up window choose “AC500 PM571” as Configuration and press OK. In the new window choose POU type to be “Program” and language to be “FBD” which is an abbreviation for Function Block Diagram. Refer to the figure below.



Now that the project is created, it is time to configure the input/output modules connected to the PLC. This can be done in the following way.

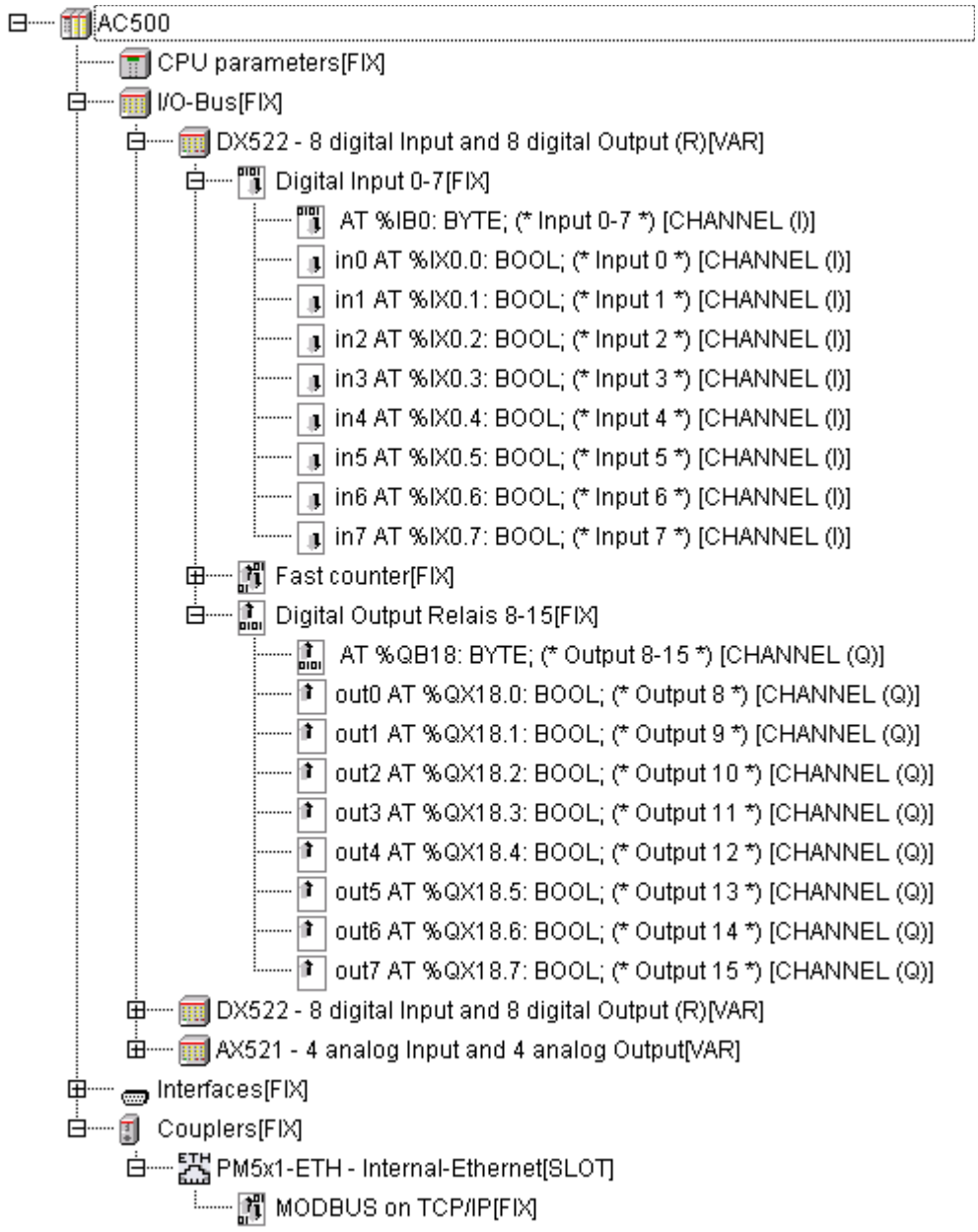
- Open the “Resource” tab in the lower left corner and double-click on the menu item “PLC Configuration”
- Check “Save configuration files in project” to save your settings.
- Fold out “AC500” if this is not done already.
- Right click on “I/O-Bus[FIX]”, choose “Append Subelement” and add a digital I/O module: DX522.
- Right click on “I/O-Bus[FIX]”, choose “Append Subelement” and add another digital I/O module: DX522.
- Right click on “I/O-Bus[FIX]”, choose “Append Subelement” and add the analog I/O module: AX521.
- Fold out “Couplers [FIX]”, right click on “Internal-None” and choose “Replace Subelement” and add the “PM5x1-ETH - Internal-Ethernet” coupler.

The three I/O modules are placed at the right side of the PLC. The small control panel with three switches and lights are connected to the first digital DX522 module. Hence a name should be given to the I/O points of this module. This is done by folding out the DX522 digital inputs and digital outputs as showed below.




Click on AT a number of times to get the text box. The given names are now automatically created as global variables that are accessible to programs.

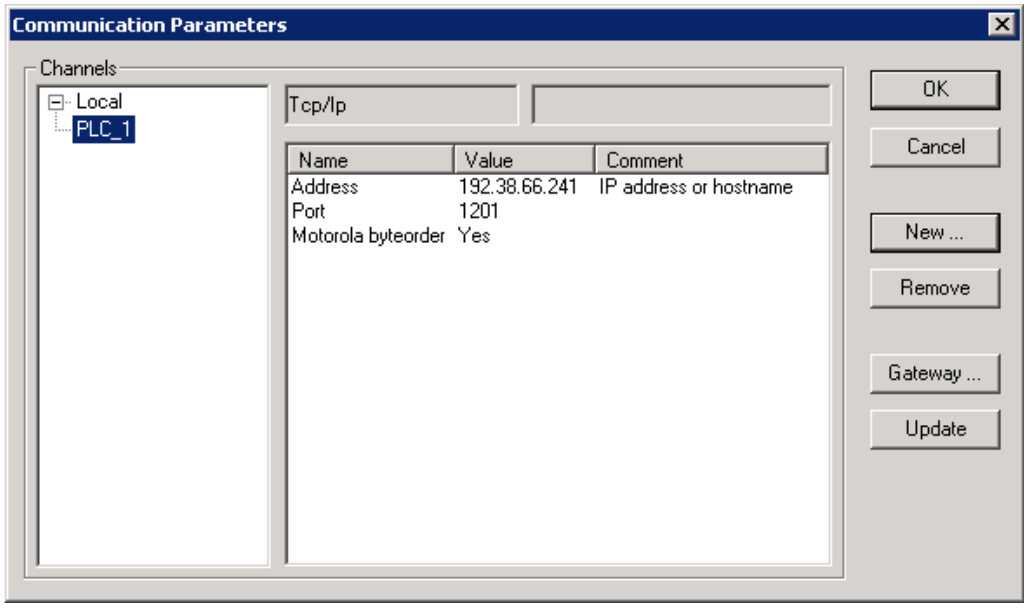
The final configuration should resemble the one shown below.




The PLC and CoDeSys communicates via the ethernet. The settings for that communication is setup in the following way.

- Choose the menu Online → Communication Parameters.
- Choose new and give the interface a suitable name (like ‘PLC_x’). Choose the Device “Tcp/Ip” and press OK.
- Click at the element you have just created. Change the Address to the IP number. The PLCs has IP 192.38.66.24x where x is the PLC number [1-8].
- Change Port to 1201 and Motorola Byteorder to “Yes” (leftclick on No until it changes).

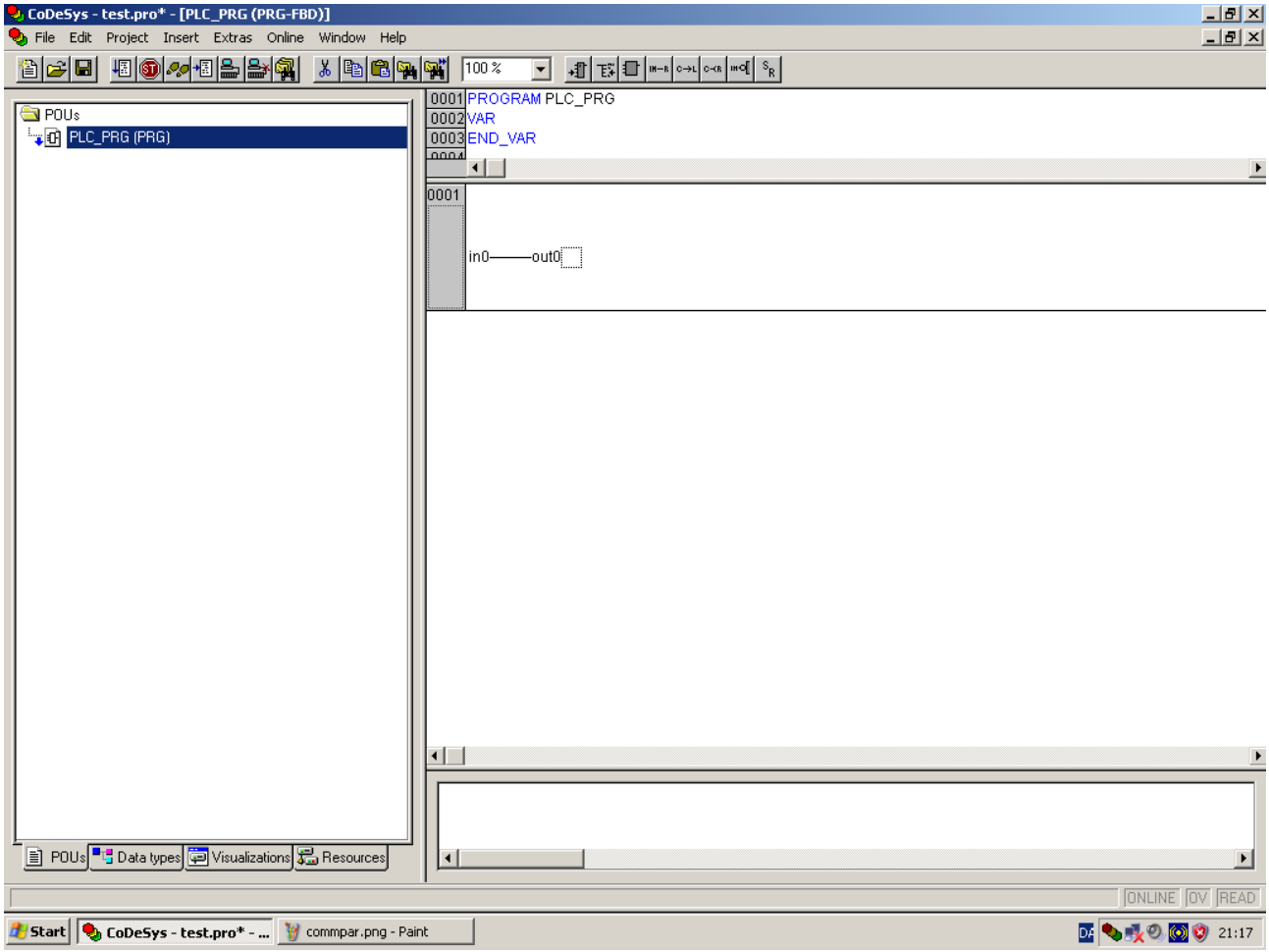
The communication settings are shown below for PLC 1.




Now is a good time to save the project (File → Save). The project can be used as a prototype for the programs you create from now on.

**My First Program: Hello World!**

The purpose of the first PLC program is to connect a digital input to a digital output, and thereby make it possible to control a light with a switch, on the control box.
Open the “POUs” tab in the lower left corner and double click on “PLC_PRG (PRG)”.
The screen should look like the next screen shot. The network on the figure should be created. Click on the “???” above the contact and press F2. The “Global Variables” list should contain the names you gave the digital I/Os above. Choose input pin 0 from the list and press OK. Right click to the right of the name in the program window and press 'ctrl+a' to append. Then press F2 and choose output pin 0. Your program should now look like the next figure. To compile choose Project → Rebuild All.
Then choose Online → Login to download the program to the PLC. When this is done press F5 to put the PLC in running mode. You should now be able to control one of the lights by one of the switches on the control box. Note also that CoDeSys paints the lines that are active blue.




**Basic logic functions**
Create PLC networks for each of the basic logic functions AND, OR, NAND, NOR and XOR. Use the switches and lights on the control box to verify your programs.

**Logic Function**
Implement a network or networks that acts as described in the following truth table. Use the switches and lights on the control box as verification.

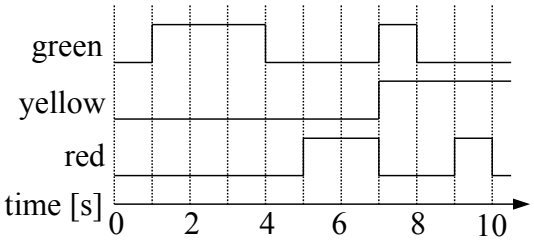
| Switch 1 | Switch 2 | Switch 3 | Red light | Yellow light | Green light |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 | 1 | 1 |
| 0 | 1 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 0 |

What is the lowest number of logic gates necessary to implement this ?

**Latch**
A latch is useful for keep systems running given a short input starting pulse. Look up how a latch can be implemented using logic expressions and try to implement one using the control box middle button as input.

**Timers**
Timers are very important when programming sequences using PLCs. There exist different types of times and in this exercise we use the on-delay timers (TON). To add a timer to a network right click on the network and choose “Box”. This usually creates an “AND” function block, but changing “AND” to “TON” will change the function block to a timer. To add a time to the TON use the PT input. The format is “T#2s” to get a 2 seconds delay.

Implement the following timing sequence using the lights of the control box.




*Hint: A clue to creating the pulses can be found at: http://aut.elektro.dtu.dk/staff/sh/plc/faq_q4.html*

**Journal**
As a minimum the journal should contain answers to the questions, commented screen shots of your solutions for all exercises. The journal should be uploaded to DTU-Inside in the usual way.