

Codesys

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UNIMORE
UNIVERSITÀ DEGLI STUDI DI
MODENA E REGGIO EMILIA

High Performance
Real Time **Lab**

“

Programming is a skill
best acquired by practice
and example rather than
from books.

ALAN TURING



Load the main program interface

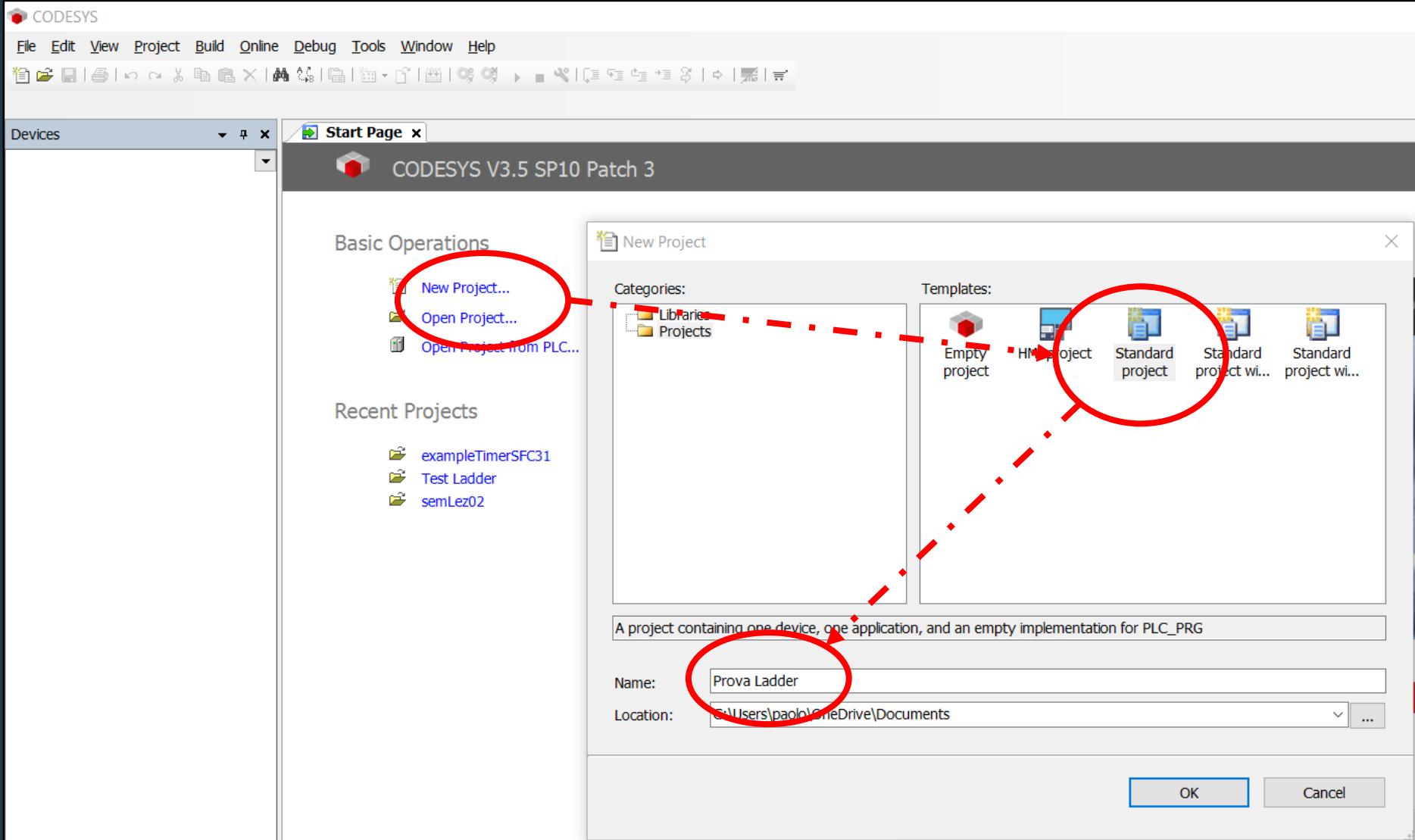
What is it?

- › An IDE to create PLC programs, and **simulate them**
- › In any of the five main languages
- › I use V3.5 SP1 patch 3, recommended version (for compatibility with the examples I'll give you)



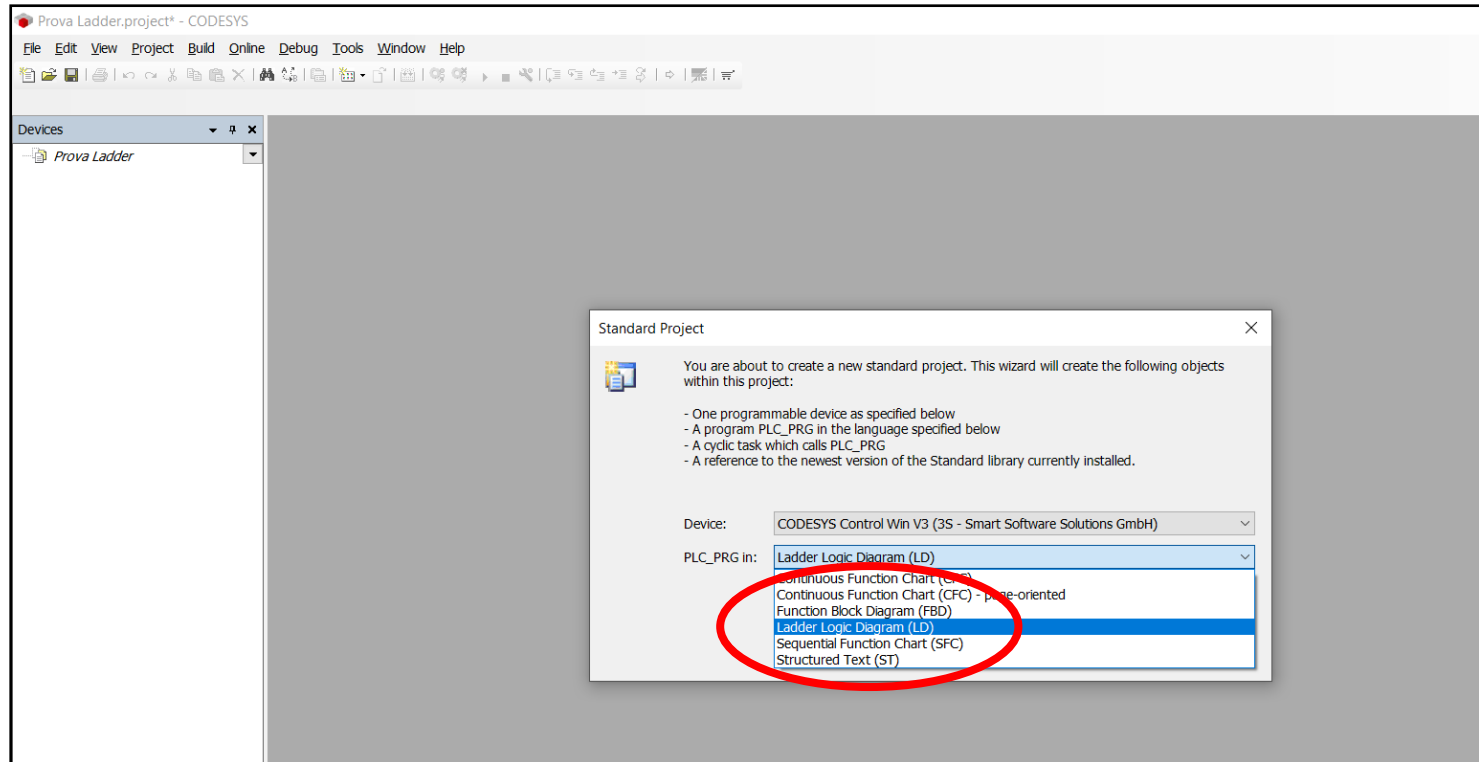


Create a project





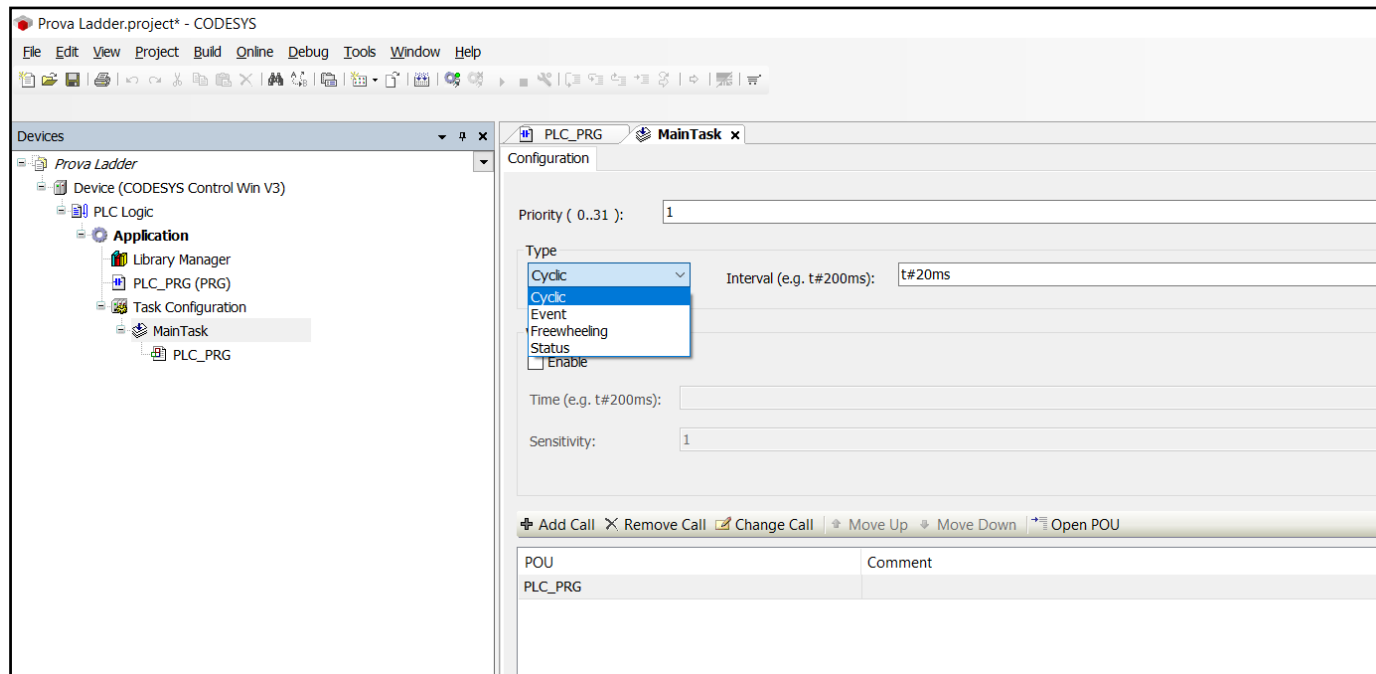
Select the language





Project workbench

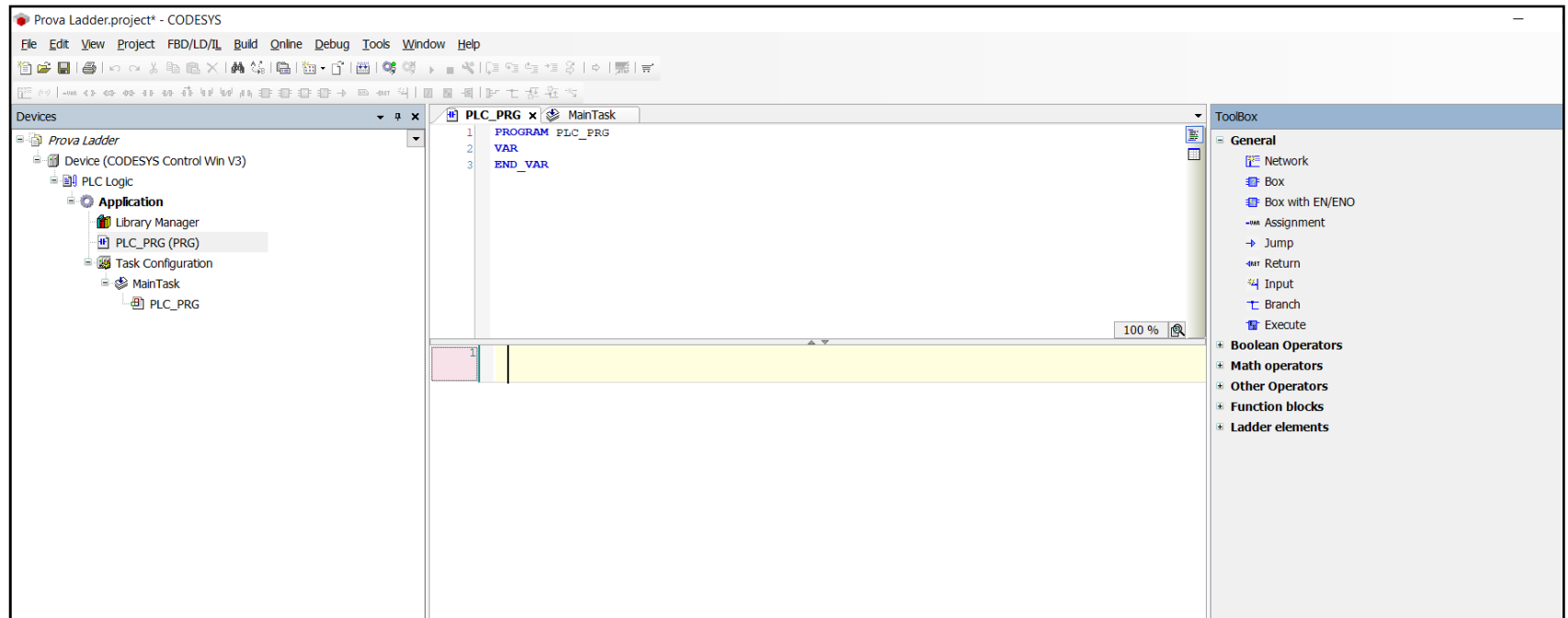
- › Your application has a Main task, that (here) runs cyclically





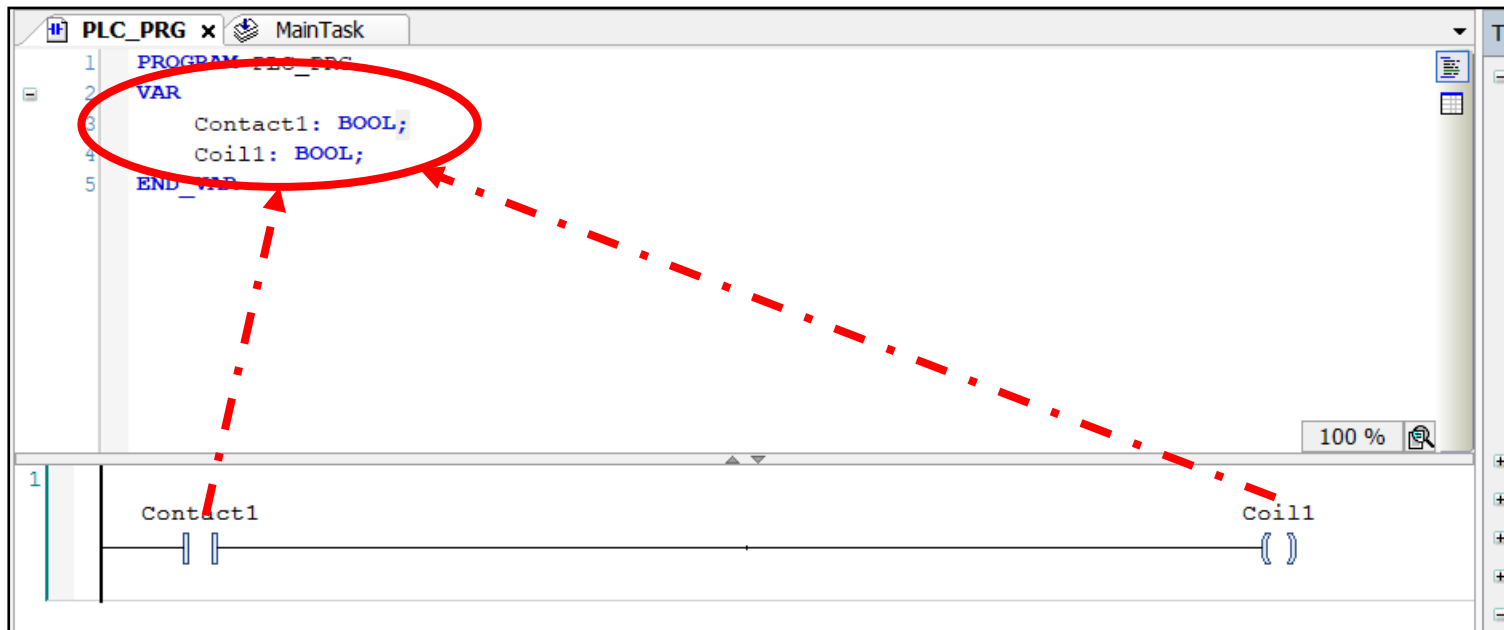
Project workbench - Ladder

- › You can create Ladder diagrams using drag/drop from the toolbox



Adding a contact + coil

- › Two global variables are automatically created in the variable definition window always in ST lang), both of `bool` type, as specified by us
- › Here, we want a switch that turns on a lamp, hence we need a NO contact and a coil
- › PS here you don't see the right power rail as it's implicit

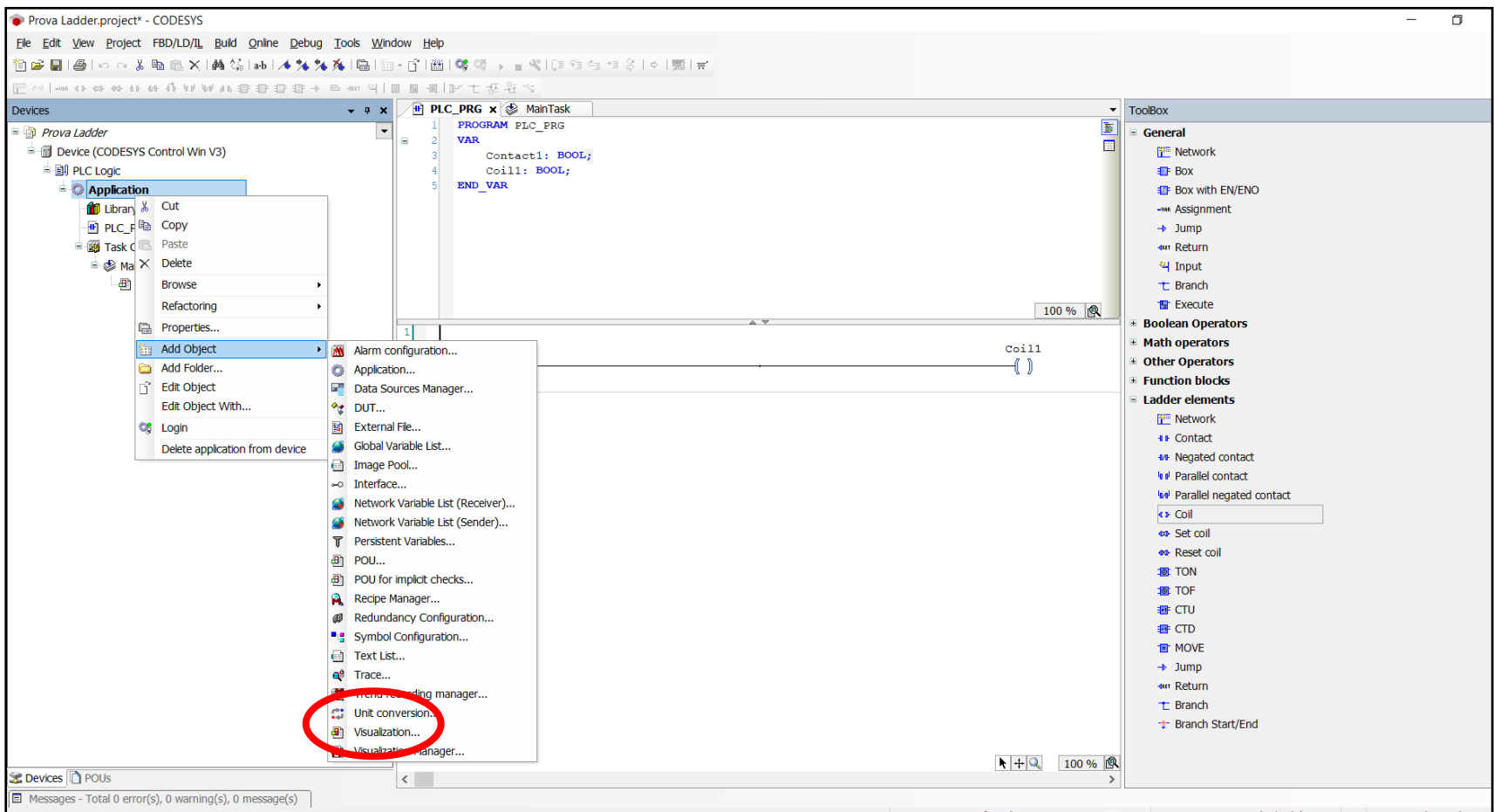




View the simulated system

Add a Visualization object

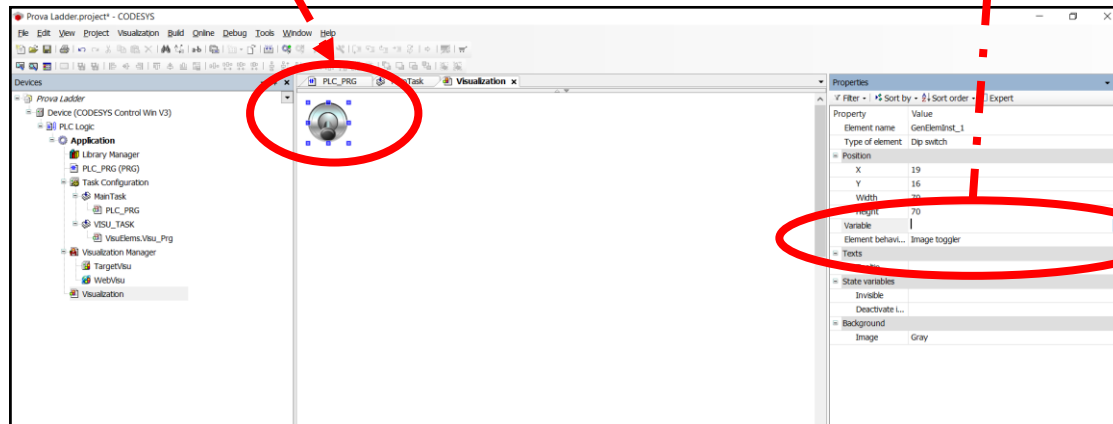
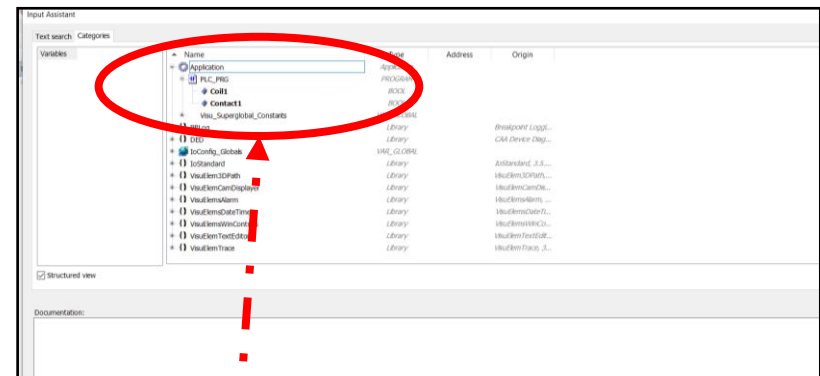
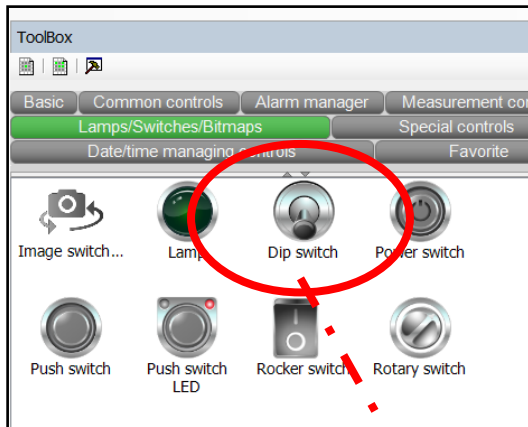
› Application -> Add Object -> Visualization





Add elements, and link to variables

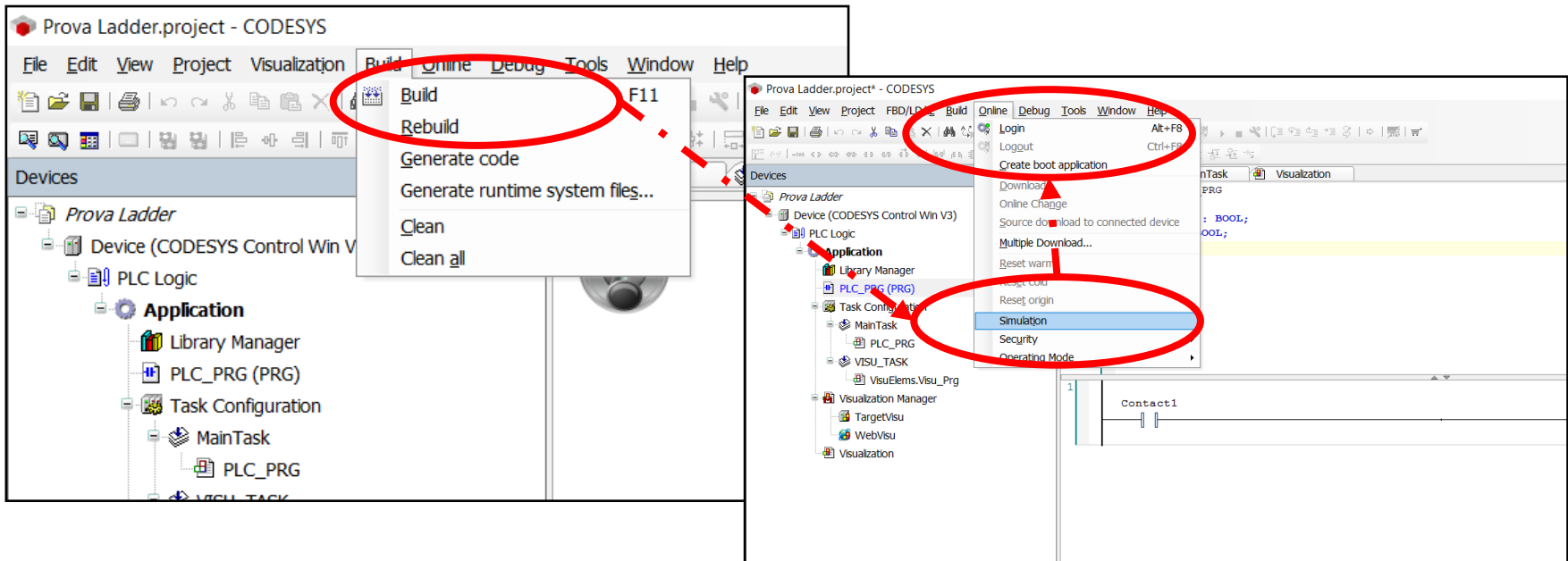
- › Here, we added a dip switch from the toolbox, and we select the `Contact1` var from the Properties window
- › Now, add a lamp and bind it to `Coil1`





Compile and set up simulator

- › Build the system, from the menu or with F11
- › Login from the Online menu to download the required run libs
 - Before..make sure you ticked “Simulation”!
- › Now, we’re ready to go





Run workbench

- › After a while, simulator/simulation is set up
- › Click on Debug -> Start to go
- › Nothing happens

The screenshot shows the CODESYS Prova Ladder project interface. The left pane displays the project tree with 'Prova Ladder' as the root. Under 'PLC Logic', 'Application [stop]' is selected. The main workspace shows a ladder logic diagram with a single rungs containing 'Contact1' in series with 'Coil1'. The 'Visualization' pane on the right displays a table of variables and a message.

Expression	Type	Value	Pre
Contact1	BOOL	FALSE	
Coil1	BOOL	FALSE	

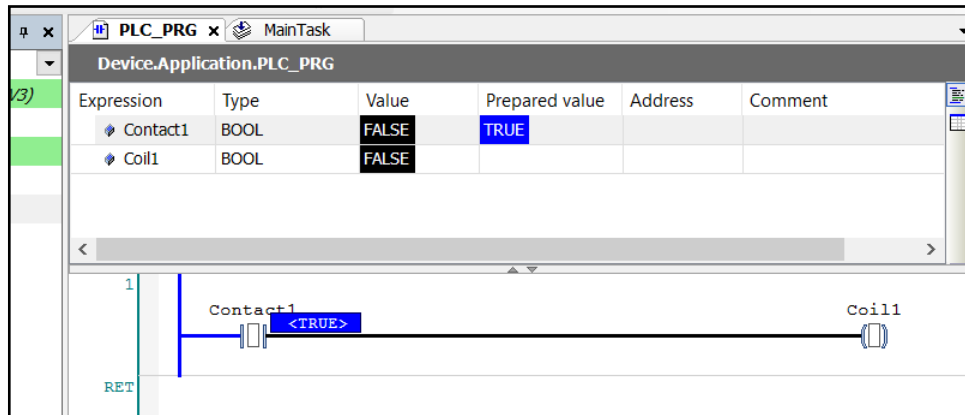
The online visualization is waiting for a connection. Please start the application.





Modify values

- › Via the “watch expression” window, use the “Prepared value”
- › Then, apply the value with the Debug -> Write value menu item (or CTRL+F7)



- › In this case, in our example, we can also manually acting on the switch

Remember to log out after you're done! 😊



Sequential contacts vs. parallel contacts

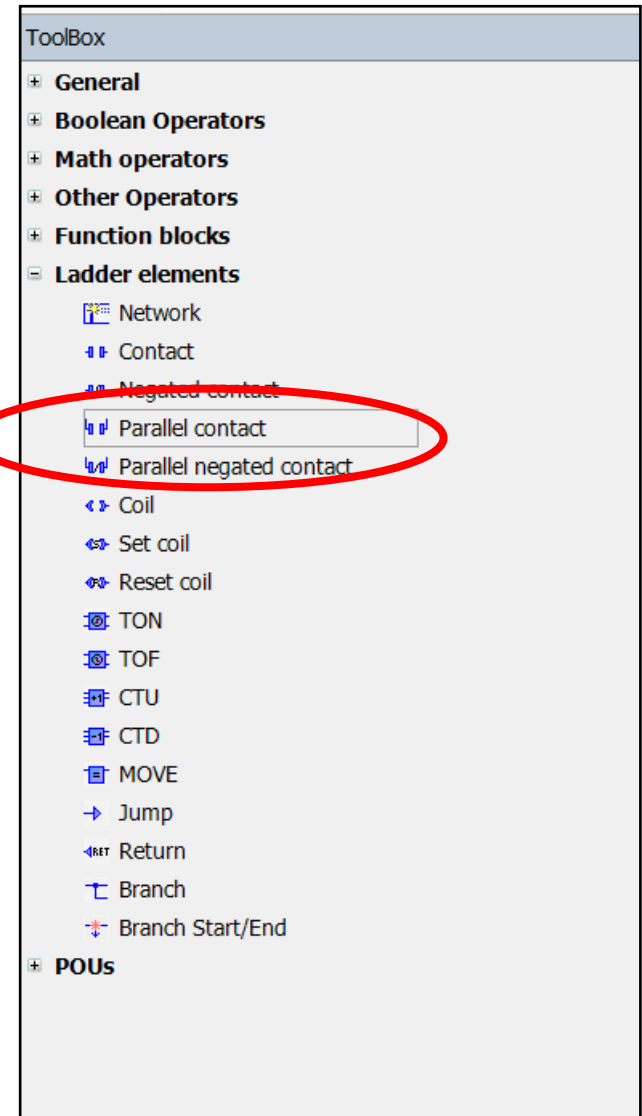
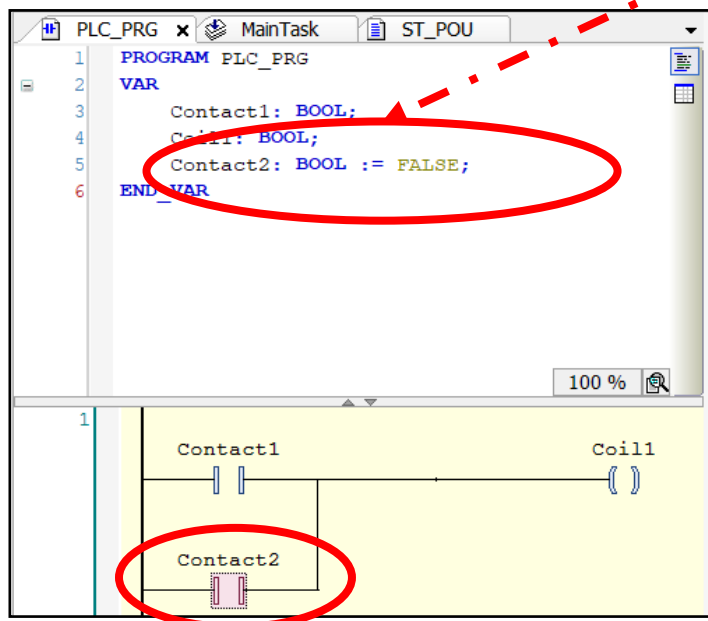
Logical “AND”


- › ..easy, simply drag&drop

Logical “OR”


- › “Parallel contact” components from toolbox
- › IDE helps us to insert it...

PS good programmers remember to initialize vars ;)





Structured Text



Add new ST POU

- › Program Organization Unit let you add logics in the same application, using different languages
- › We now add a **Program POU**

IEC 61131 does not allow spaces in names

The name must be a valid identifier according to the IEC 61131-3 standard.

Return type:

Implementation language:
Structured Text (ST)

POU

ST_POU



Write the ST code

Prova Ladder.project* - CODESYS

File Edit View Project Build Online Debug Tools Window Help

Devices

- Prova Ladder
 - Device (CODESYS Control Win V3)
 - PLC Logic
 - Application
 - Library Manager
 - PLC_PRG (PRG)
 - ST_POU (PRG)
 - Task Configuration
 - MainTask
 - PLC_PRG
 - ST_POU
 - VISU_TASK
 - VisuElems.Visu_Prg
 - Visualization Manager
 - TargetVisu
 - WebVisu
 - Visualization

PLC_PRG MainTask ST_POU x

```
1 PROGRAM ST_POU
2 VAR
3     Contact1: BOOL;
4     Coill: BOOL;
5 END_VAR
6
```

100 %

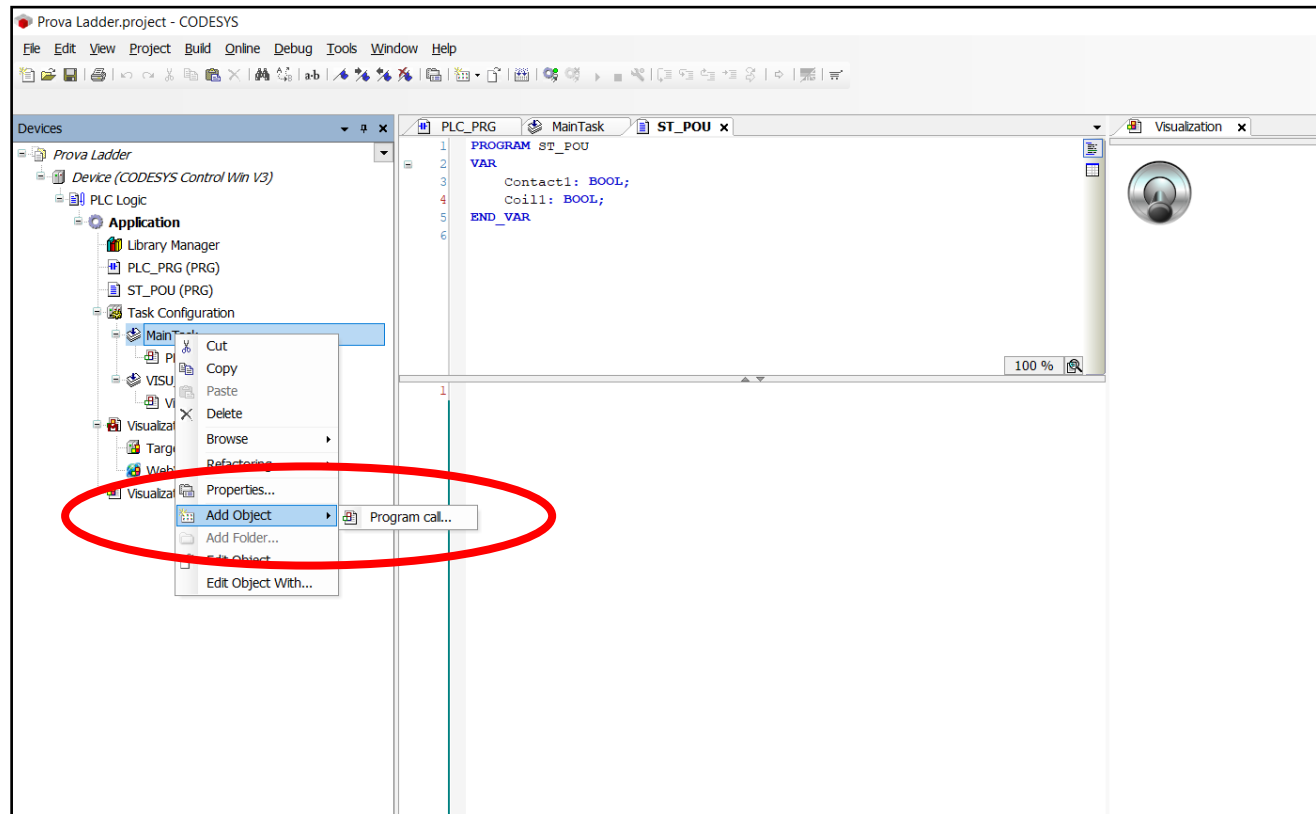
```
1 IF contact1 = TRUE THEN;
2     Coill:=TRUE;
3 ELSE;
4     Coill:=FALSE;
5 END_IF;
```

Visualization x



Are we done? Not yet...

- › We created a POU Program, but we haven't called it yet from within the MainTask...





Run and set values

- › If you set `Contact1` to `TRUE`, then `Coil1` goes to `TRUE`
- › ..but the simulated Light & Switch don't turn on!

Why?

- › Because they are **not** attached to **those** `Contact1` and `Coil1` vars you think...
- › Look out when you write names...

Should we attach those vars to the two simulated objects?

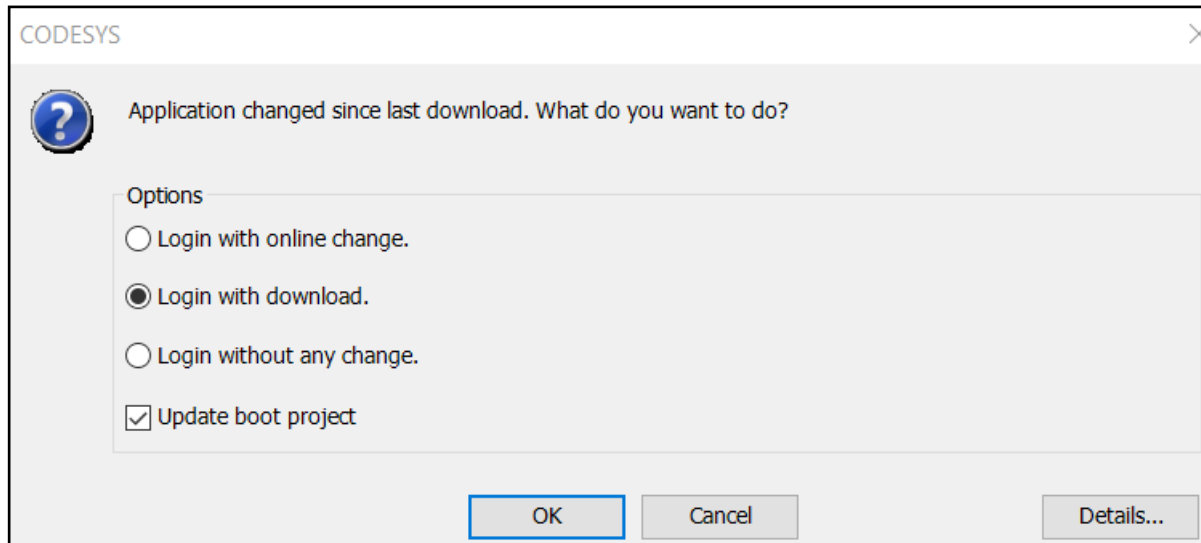
- › (recommendation) Only if requested by the application specs
- › In this case, I use them for debugging/teaching purposes, so my specs say "no" 😊



Compile & Login again

We added a ST block, so the simulation engine might require some components

› Codesys will prompt us

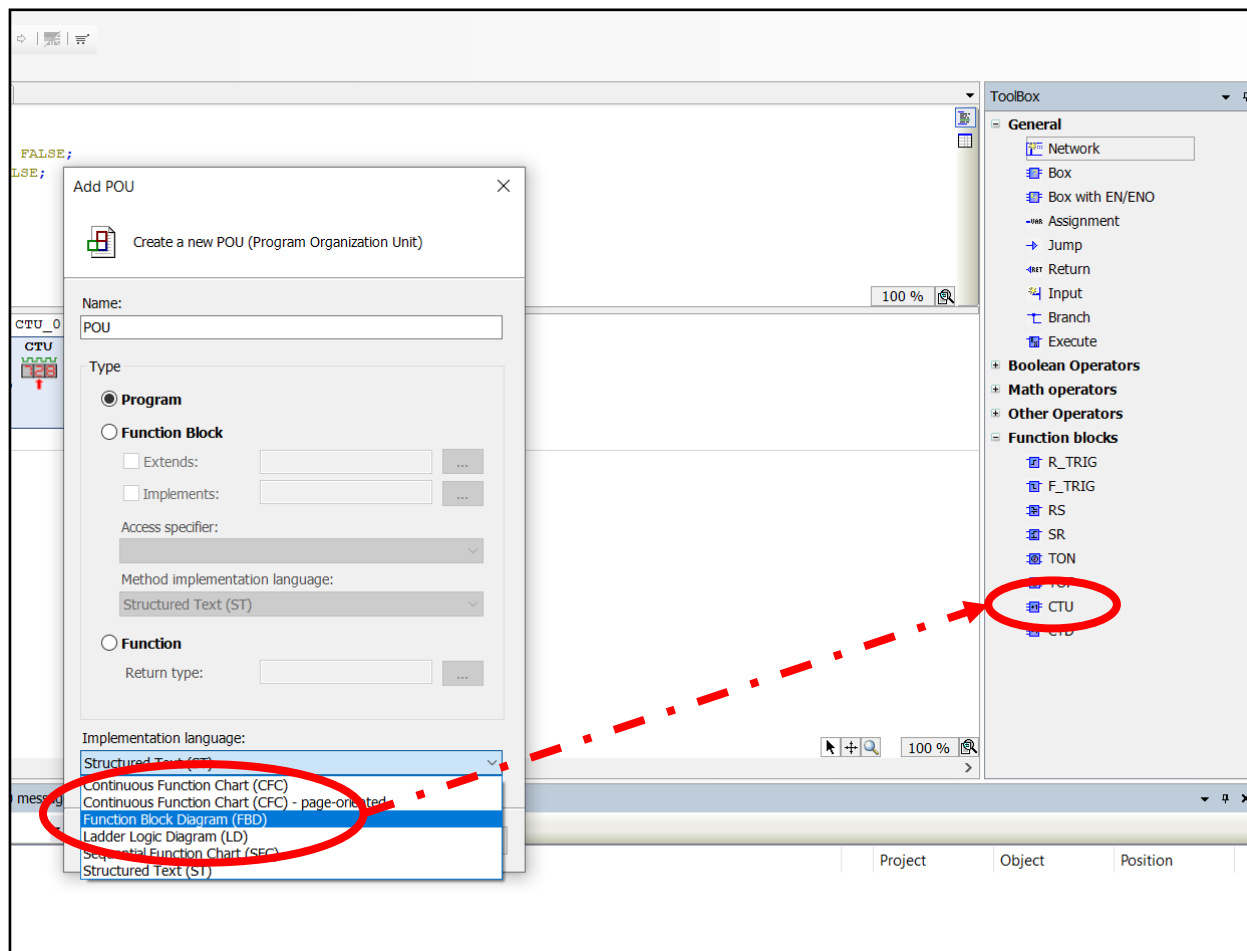




Programming with Function Blocks

Counters - CTU

- › Create a program, or add a POU of type “FBD”
- › Then, drag a Counter (CTU) in the workbench

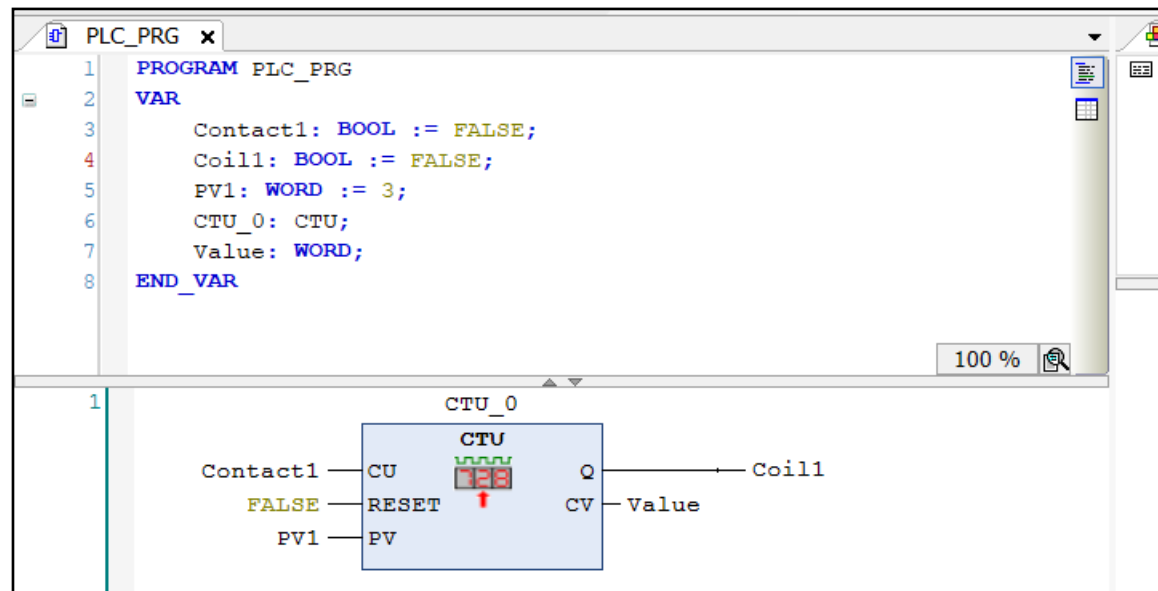




Bind the CTU

Connect CTU in&outs to vars

- › CU to a contact (press&hold button)
- › Here, RESET is false (just for this example)..might use a button/contact?
- › PV1 is a WORD
- › Q to a coil (we want to turn on a lamp)
- › CV to a WORD variable, to monitor the status





Add visualization

- › Attach a “simple” press&hold button to `Contact1`
- › Add a lamp and attach to `Coil1`
- › ..or, can also attach it directly to CTU out `PLC_PRG.CTU_0.Q`

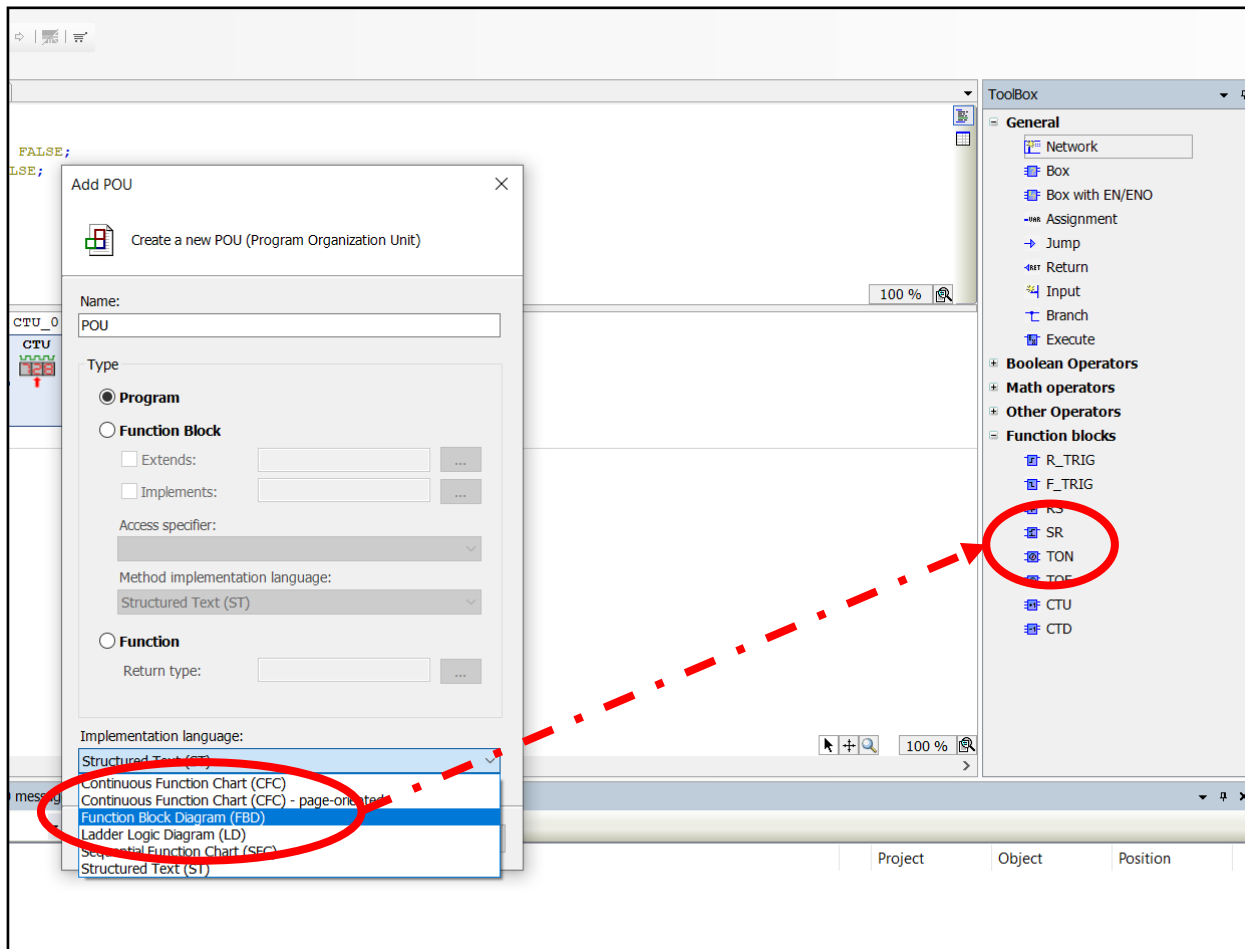
The screenshot displays the Siemens SIMATIC Manager interface with three main windows:

- PLC_PRG (Ladder Logic):** Shows a program with variables `Contact1`, `Coil1`, `PV1`, `CTU_0`, and `Value`. The ladder logic diagram shows `Contact1` as a normally open contact, `CTU_0` as a counter timer, and `Coil1` as a coil. `PV1` is connected to the `PV` (Present Value) input of `CTU_0`. The output `Q` of `CTU_0` is connected to `Coil1`, and the `CV` (Current Value) output is connected to `Value`.
- Visualization:** Shows a visual representation of the interface. It includes a "Press me" button and a lamp. The lamp is highlighted with a red circle, and a red arrow points from it to the Properties window.
- Properties:** Shows the properties of the selected element (Lamp). The "Variable" property is set to `PLC_PRG.CTU_0.Q`, which is also highlighted with a red circle.

Property	Value
Element name	GenElemInst_1
Type of element	Lamp
Position	
X	295
Y	18
Width	70
Height	70
Variable	PLC_PRG.CTU_0.Q
Texts	
Tooltip	
State variables	
Visible	

Timers – TON

- › Create a program, or add a POU of type “FBD”
- › Then, drag a Timer On (TON) in the workbench





Bind the TON

- › IN to a contact (press&hold/standard button)
- › Remember, IN starts timer @its rising edge, and resets @its falling edge
- › PT1 is a TIME
- › Q to a coil (we want to turn on a lamp) using the **assignment** operator
- › ET to a TIME variable, to monitor the status

The screenshot displays a PLC programming environment with three main windows:

- PLC_PRG x**: Contains the following code:

```
1 PROGRAM PLC_PRG
2 VAR
3   Contact1: BOOL := FALSE;
4   Coill1: BOOL := FALSE;
5   PT1: TIME;
6   Value: TIME;
7   TON_0: TON;
8 END_VAR
```
- Visualization x**: Shows a ladder logic network with a TON timer block. The block has inputs for 'IN' (connected to 'Contact1') and 'PT' (connected to 'PT1'). It has outputs for 'Q' (connected to 'Coill1') and 'VALUE' (connected to 'Value'). A red dashed arrow points from the 'Q' output to the 'Coill1' variable in the code window.
- ToolBox**: A sidebar on the right containing various function blocks. The 'Box with EN/ENO' block is circled in red, and a red dashed arrow points from it to the 'Q' output of the TON block in the visualization window.



Defining Function Blocks

Create a new POU of type Function Blocks

› (of course, in ST)

Add POU

Create a new POU (Program Organization Unit)

Name:
MyFB

Type

☐ Program

☒ **Function Block**

☐ Extends: ...

☐ Implements: ...

Access specifier:
...

Method implementation language:
Structured Text (ST)

☐ Function

Return type: ...

Implementation language:
Structured Text (ST)

Add Cancel



Implement the Function Block

Add in/out vars

- › num1, num2 as ins, SumResult and SubResult as outs, all REAL numbers

Add FB logics

- › In ST workbench

```
1 FUNCTION_BLOCK MyFB
2 VAR_INPUT
3     num1: REAL;
4     num2: REAL;
5 END_VAR
6 VAR_OUTPUT
7     AddResult: REAL;
8     SubResult: REAL;
9 END_VAR
10 VAR
11 END_VAR
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```



Use it in the Application

In the main POU, create vars

- › A and B are assigned, respectively, 11 and 5
- › Also, instantiate the FB

The screenshot shows a software interface with a project tree on the left and a code editor on the right. The project tree includes 'SYS Control Win', 'ion', 'y Manager', '(FB)', 'PRG (PRG)', 'Configuration', 'ainTask', and 'PLC_PRG'. The code editor has two tabs: 'MyFB' and 'PLC_PRG x'. The 'PLC_PRG x' tab is active, displaying the following code:

```
1 PROGRAM PLC_PRG
2 VAR
3     A: REAL := 11;
4     B: REAL := 5;
5     Sum: REAL;
6     Subtr: REAL;
7     SumAndSubtract: MyFB;
8 END_VAR
```

Below the code editor, there is a ladder logic editor showing a single rungs with a yellow background and a vertical line at the start.



Call the FB from application

Need to explicitly bind FB input vars to main POU the vars

- › E.g., A to num1
- › Can use dot notation to fetch output values, after calling

Slightly different than in “traditional” programming languages

- › Why?

RG)	8	END_VAR
ration		
RG	1	SumAndSubtract(num1 := A, num2 := B);
	2	
	3	Sum := SumAndSubtract.AddResult;
	4	Subtr := SumAndSubtract.SubResult;





Simulate..and enjoy! 😊

MyFB PLC_PRG x

Device.Application.PLC_PRG

Expression	Type	Value
A	REAL	11
B	REAL	5
Sum	REAL	16
Subtr	REAL	6
SumAndSubtract	MyFB	

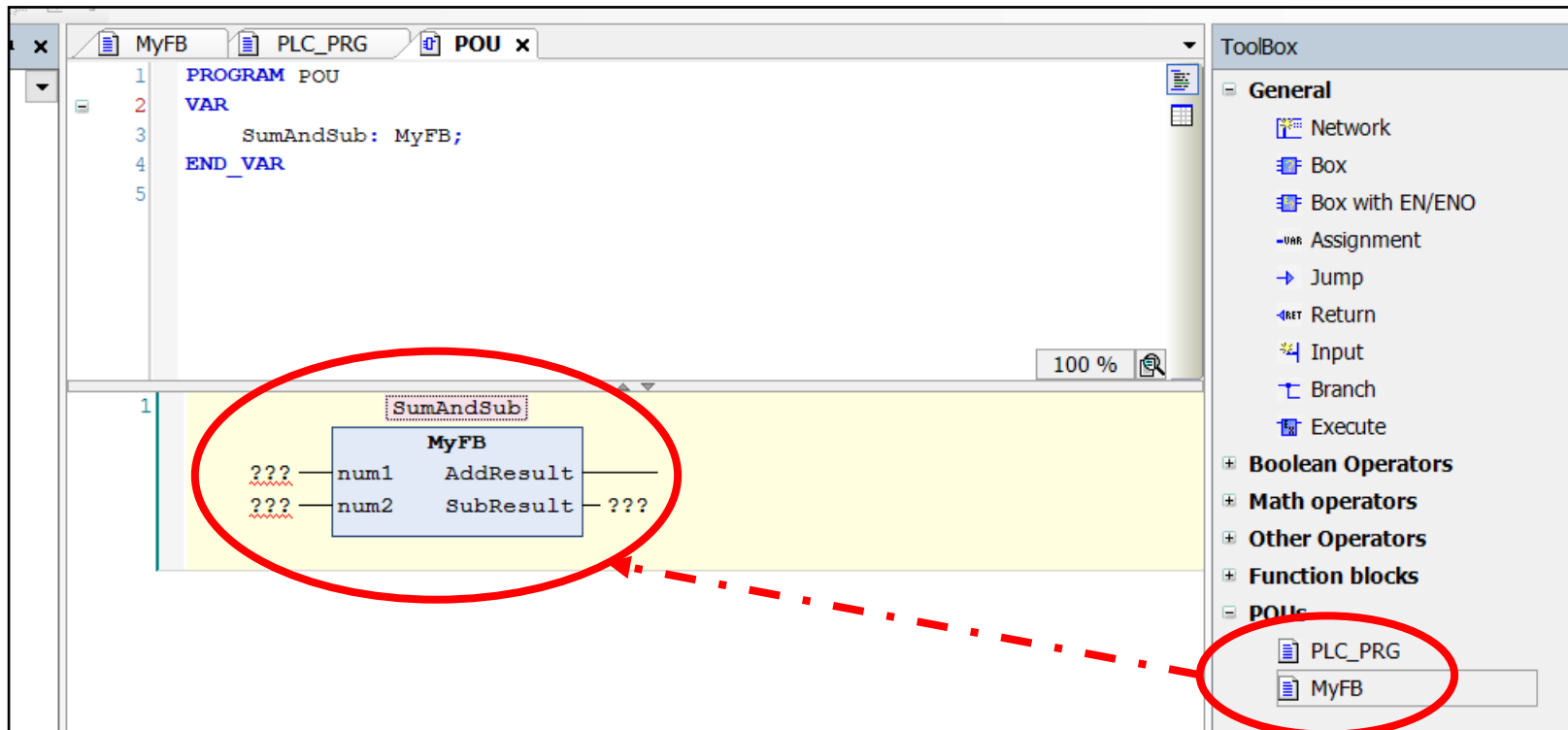
```
1 SumAndSubtract (num1 11 := A 11, num2 5 := B 5);  
2  
3 Sum 16 := SumAndSubtract.AddResult 16;  
4 Subtr 6 := SumAndSubtract.SubResult 6; RETURN
```



Call from another POU

Now, your amazing FB can be used in another POU!

- › Instantiate a FBD POU
- › Find MyFB in the toolbox
- › Instantiate and try it!





Exercise

Let's
code!

Implement any of the automatas that we saw so far using an FSM written using `ST CASE-SWITCH`

- › Base automata

*“Identify even sequences of a (even empty),
followed by one, or more, or no, b, ended by c”*

- › The traffic light

- › Whatever you want!

You might want to use Function blocks to separate and test different functionalities using different POU's



How to run the examples

Let's
code!

- › Find them in `Code/` folder from the course website

To download Codesys, ask the teacher, or open an issue in our GitHub page



References



Course website

- › http://hipert.unimore.it/people/paolob/pub/Industrial_Informatics/index.html

My contacts

- › paolo.burgio@unimore.it
- › <http://hipert.mat.unimore.it/people/paolob/>

Resources

- › Brian Hobby, Codesys tutorials (a must to learn the tool in 5 mins)
- › A small blog
 - www.google.com