Codesys

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UNIMORE
UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA
High Performance Real Time Lab

“

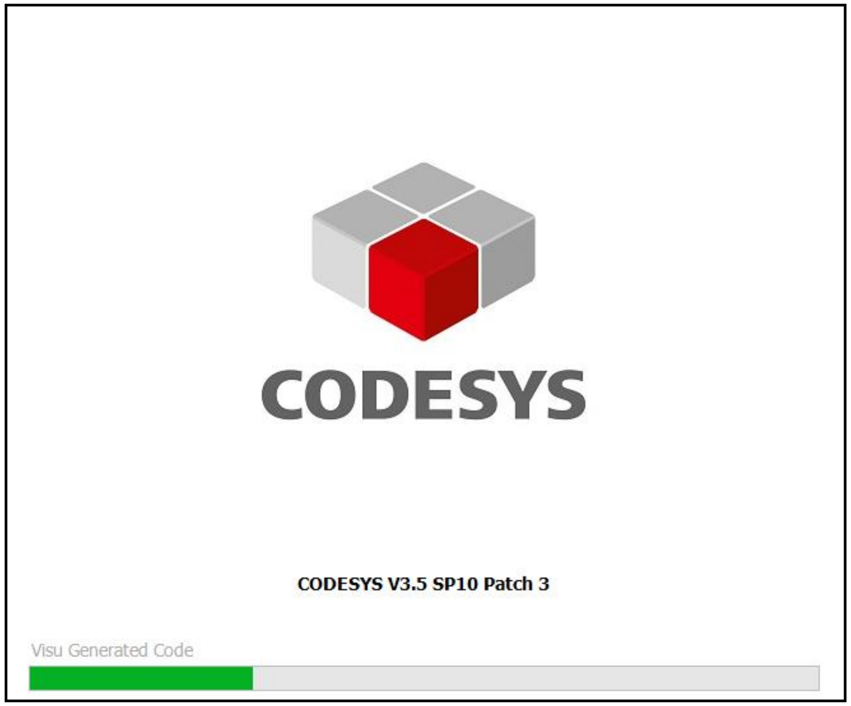
Programming is a skill best acquired by practice and example rather than from books.

ALAN TURING

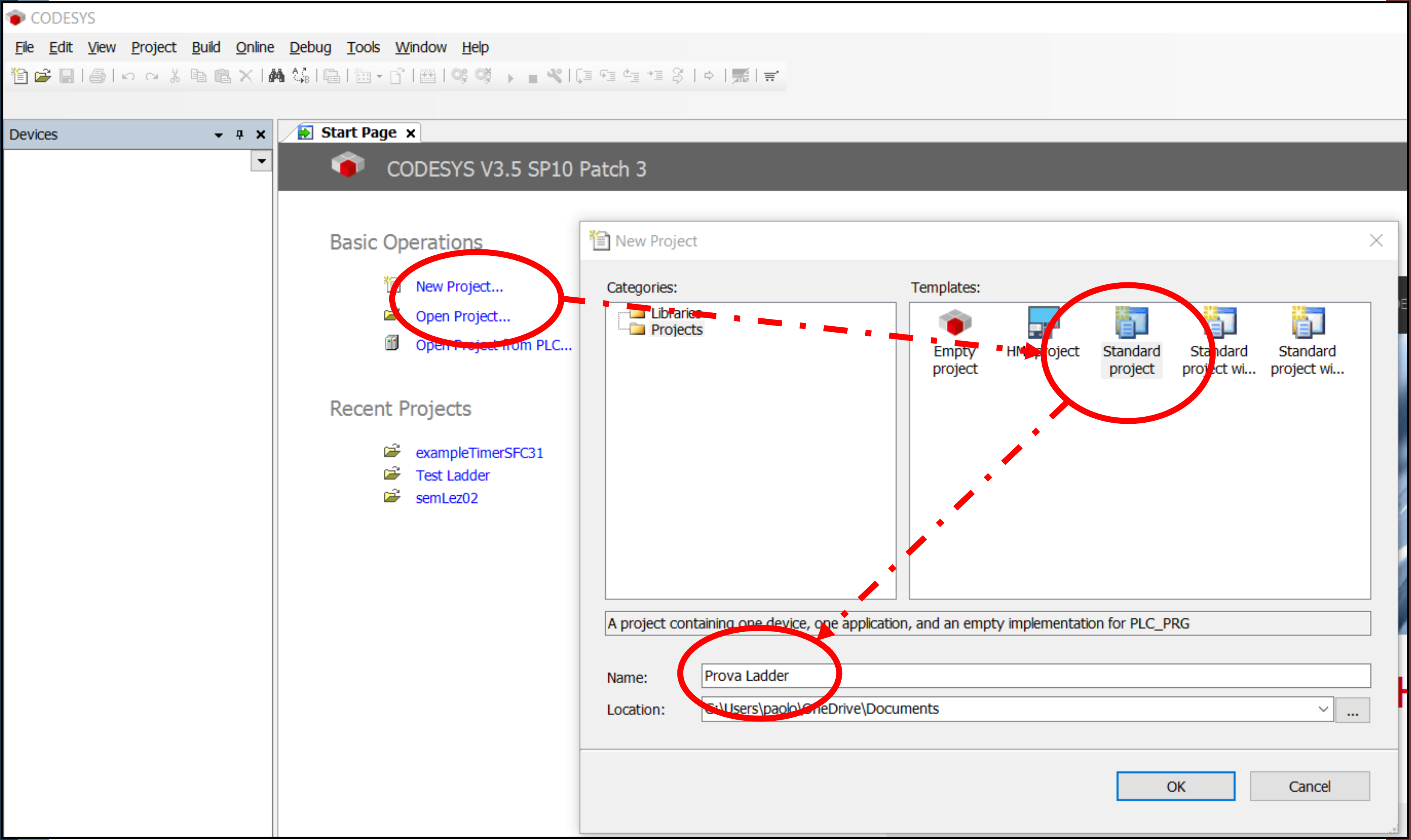
Load the main program interface

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

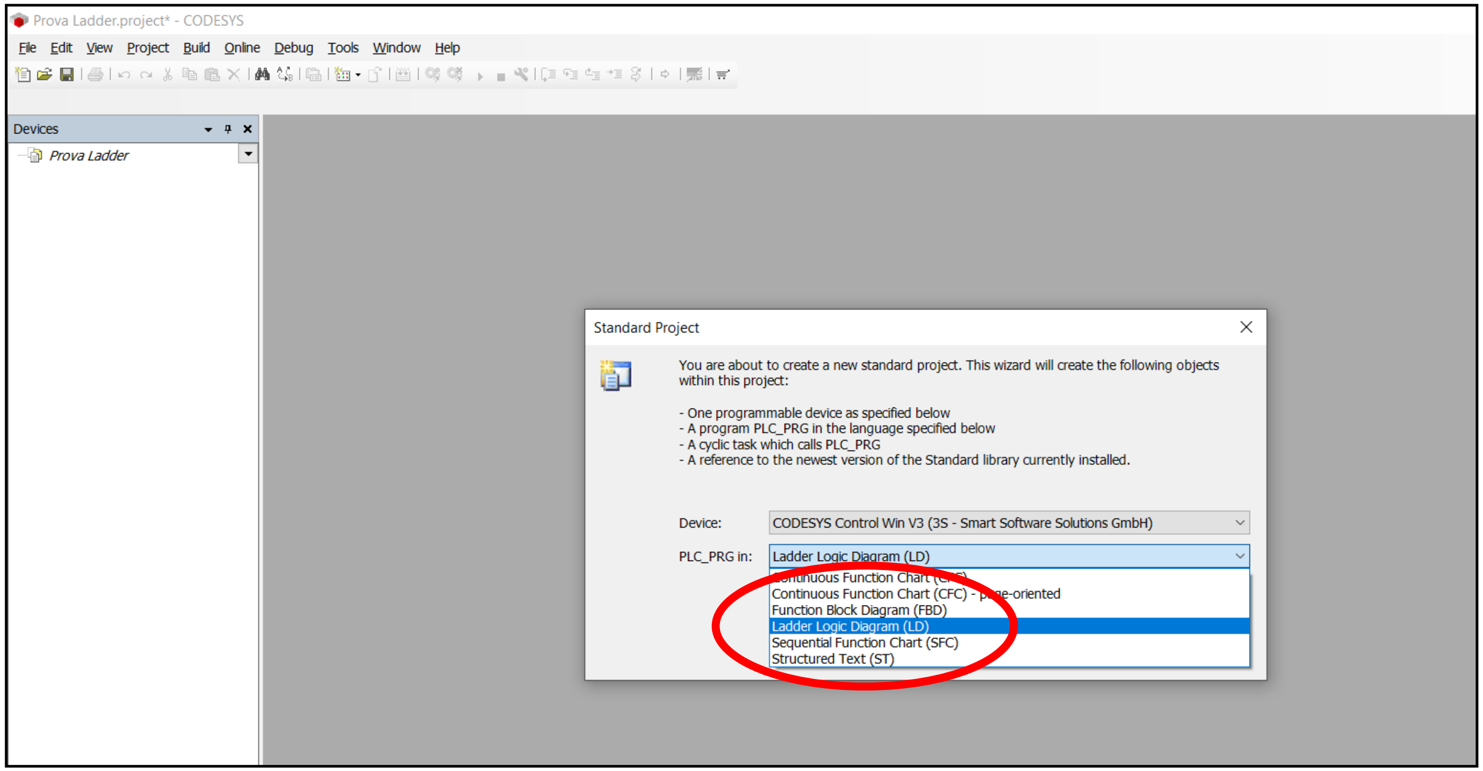


A project containing one device, one application, and an empty implementation for PLC_PRG

Name: Prova Ladder

Location: C:\Users\paolo\OneDrive\Documents

Select the language


Prova Ladder.project* - CODESYS
File Edit View Project Build Online Debug Tools Window Help
Devices
Prova Ladder
Standard Project

You are about to create a new standard project. This wizard will create the following objects within this project:

- One programmable device as specified below
- A program PLC_PRG in the language specified below
- A cyclic task which calls PLC_PRG
- A reference to the newest version of the Standard library currently installed.

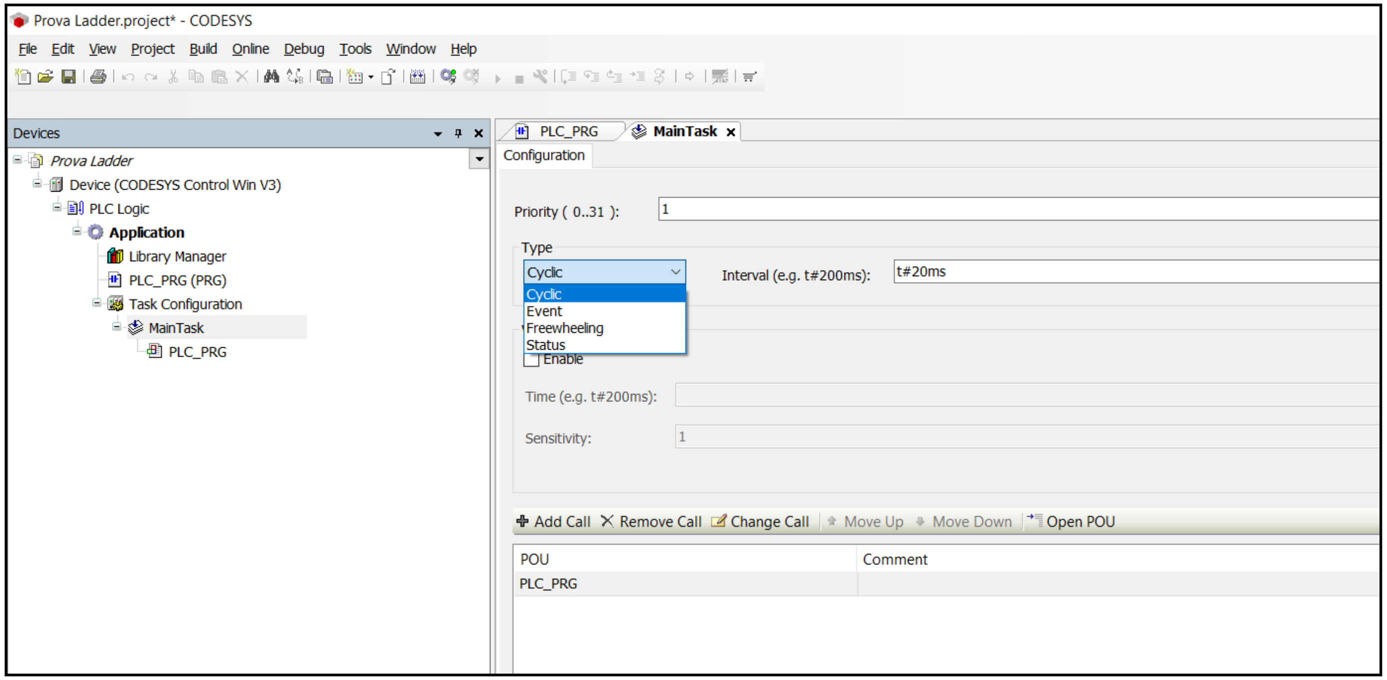
Device: CODESYS Control Win V3 (3S - Smart Software Solutions GmbH)

PLC_PRG in: Ladder Logic Diagram (LD)

Continuous Function Chart (CFC)
Continuous Function Chart (CFC) - page-oriented
Function Block Diagram (FBD)
Ladder Logic Diagram (LD)
Sequential Function Chart (SFC)
Structured Text (ST)

Project workbench

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



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)
        - Task Configuration
          - MainTask
            - PLC_PRG

PLC_PRG | MainTask

Configuration

Priority (0..31): 1

Type: Cyclic — Interval (e.g. t#200ms): t#20ms

Cyclic
Event
Freewheeling
Status

Enable

Time (e.g. t#200ms):

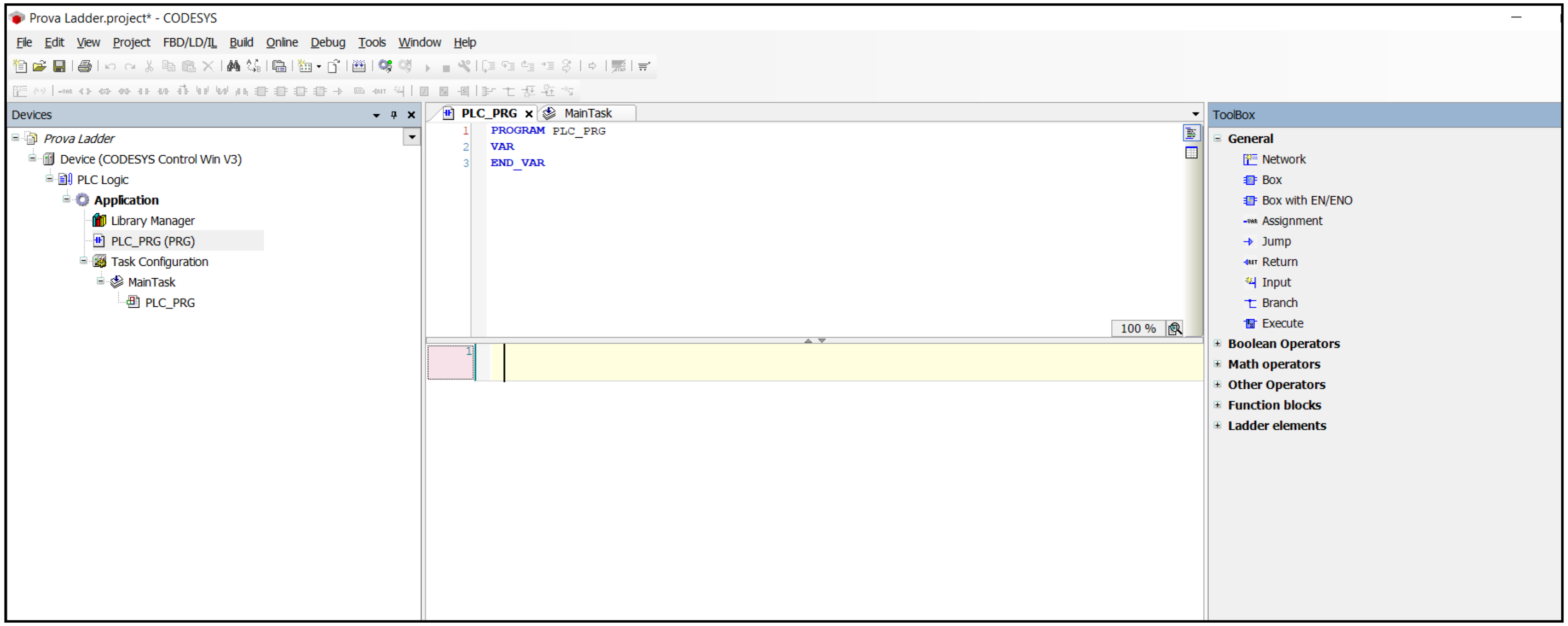
Sensitivity: 1

Add Call | Remove Call | Change Call | Move Up | Move Down | Open POU

POU	Comment
PLC_PRG	

Project workbench - Ladder

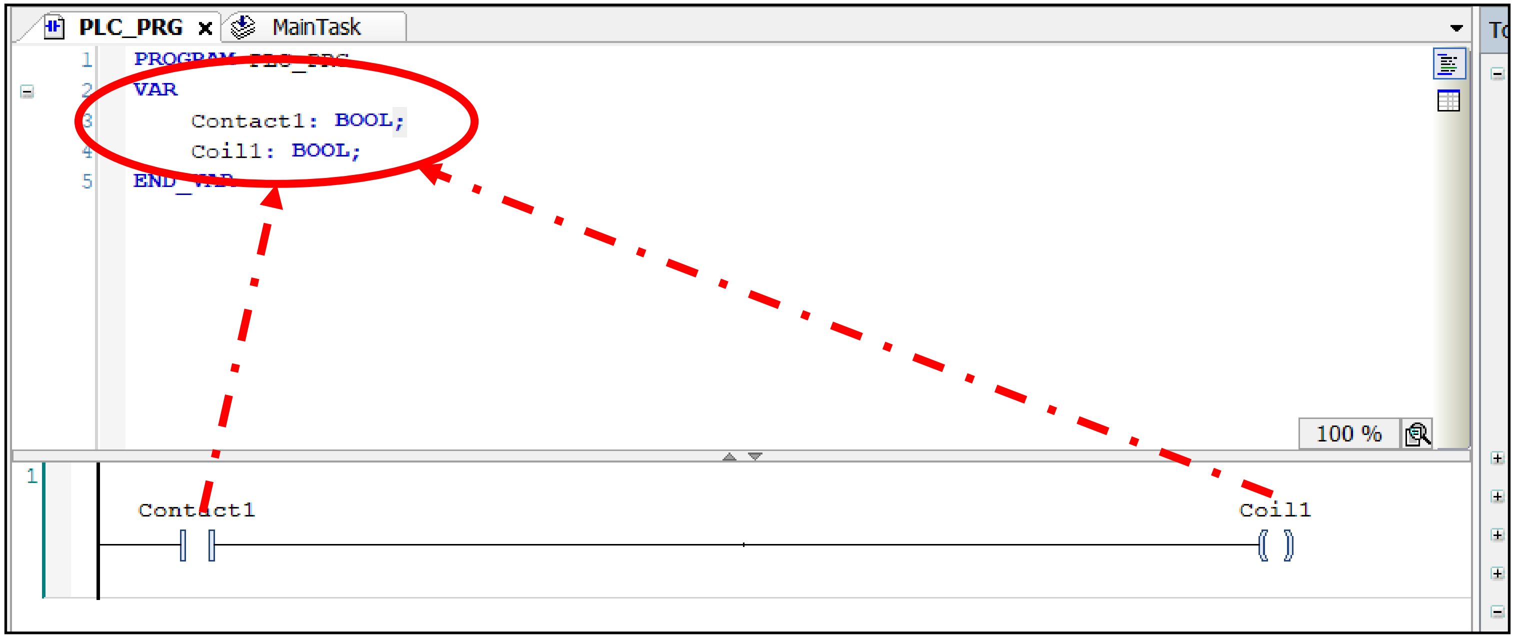
› You can create Ladder diagrams using drag/drop from the toolbox



```
PROGRAM PLC_PRG
VAR
END_VAR
```

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

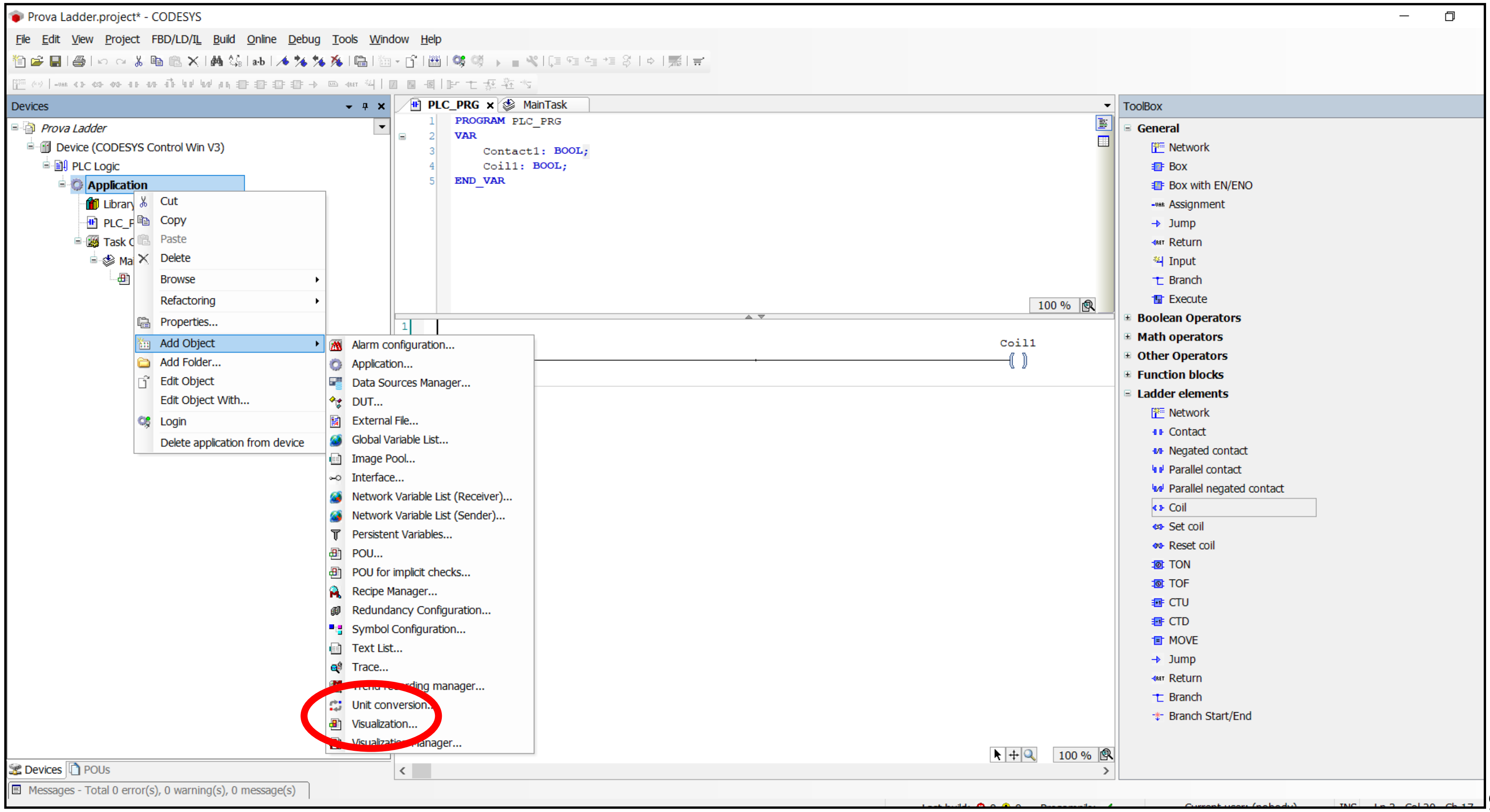


```
PROGRAM PLC_PRG
VAR
    Contact1: BOOL;
    Coil1: BOOL;
END_VAR
```

View the simulated system

Add a Visualization object

› Application -> Add Object -> Visualization



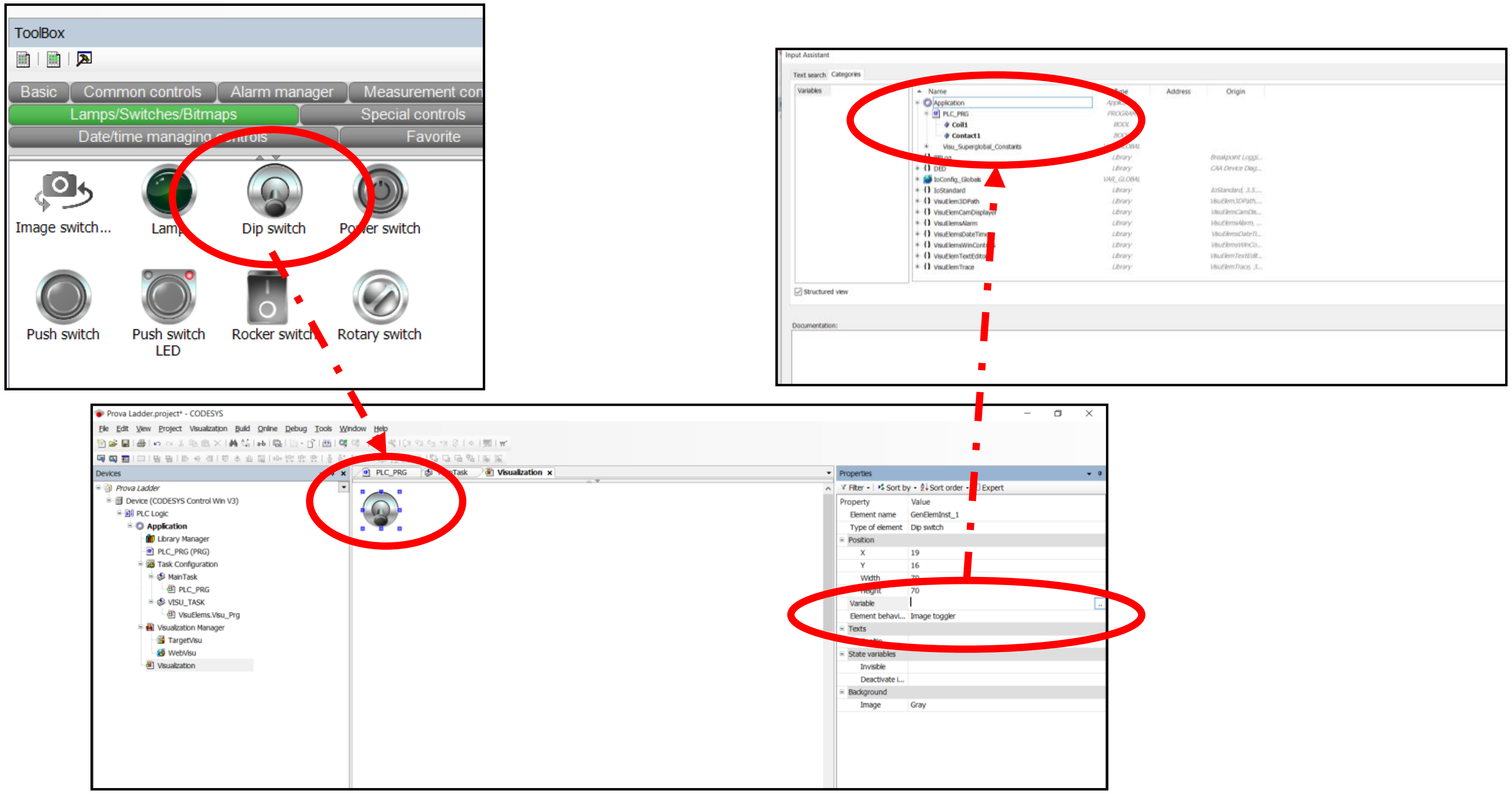
```
PROGRAM PLC_PRG
VAR
    Contact1: BOOL;
    Coil1: BOOL;
END_VAR
```

Messages - Total 0 error(s), 0 warning(s), 0 message(s)

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`



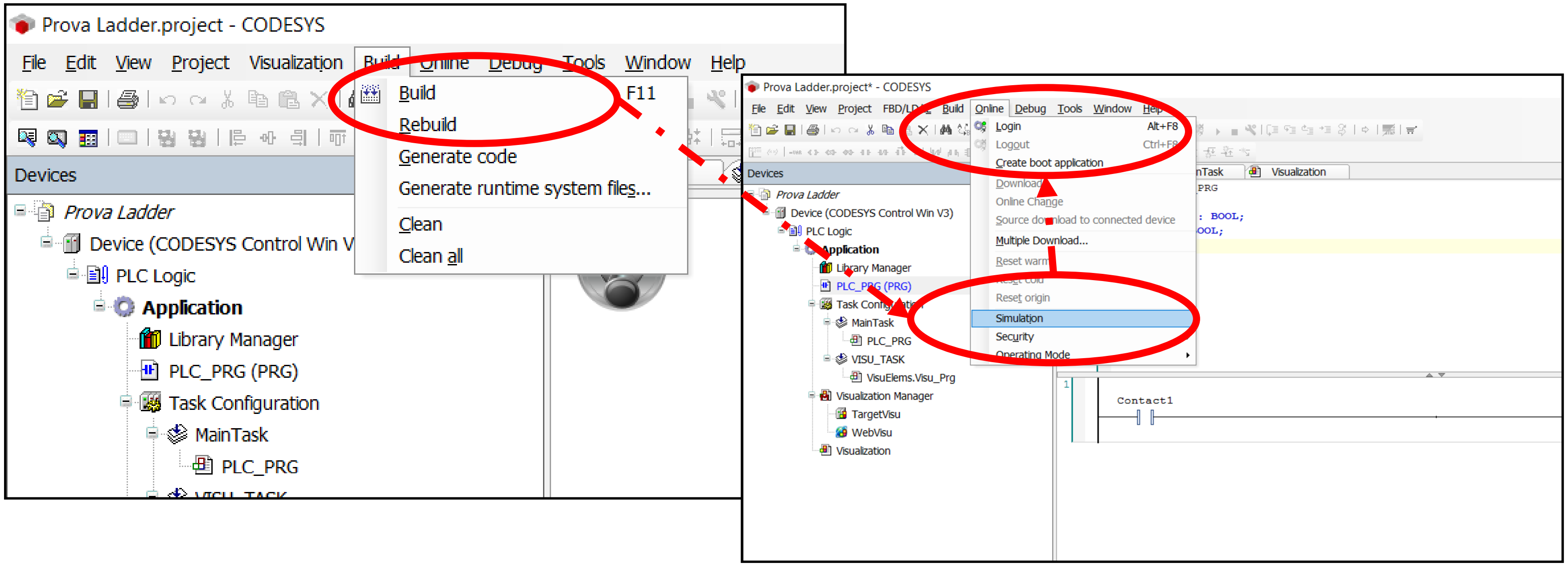
Property	Value
Element name	GenElemInst_1
Type of element	Dip switch
Position	
X	19
Y	16
Width	70
Height	70
Variable	
Element behavi...	Image toggler
Texts	
State variables	
Invisible	
Deactivate i...	
Background	
Image	Gray

Compile and set up simulator

› Build the system, from the menu or with F11

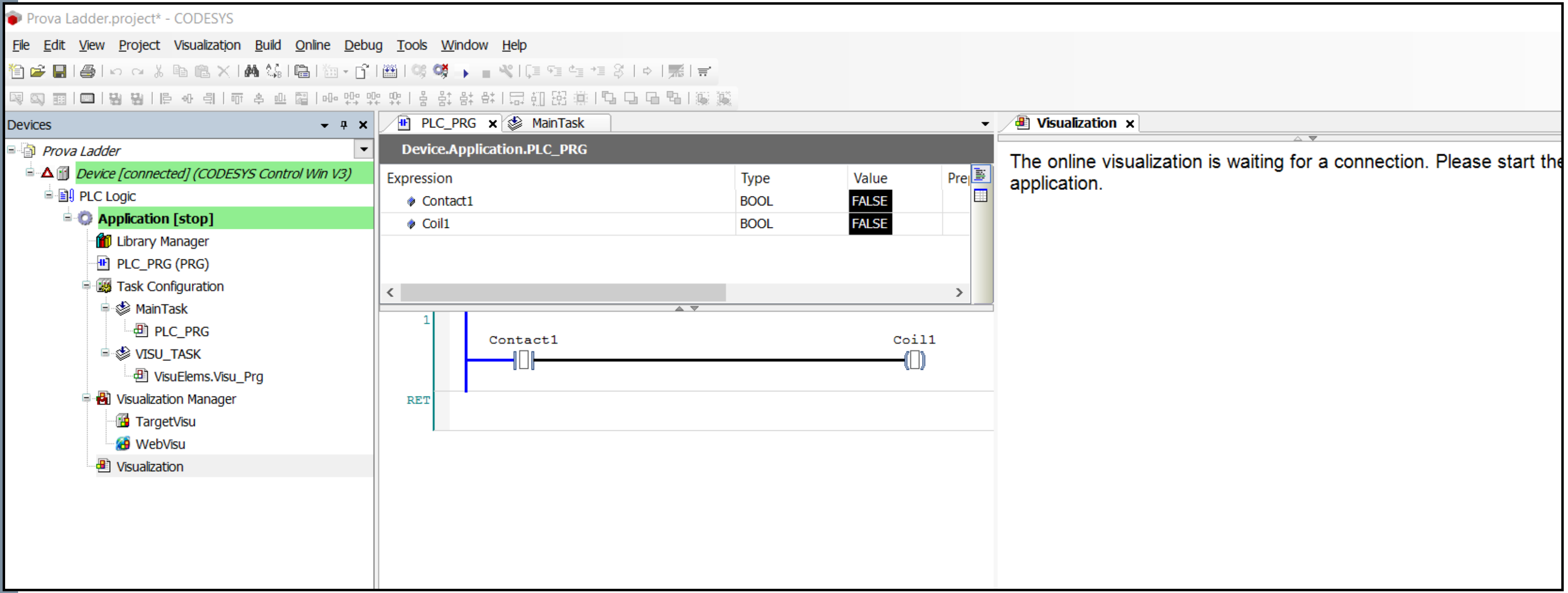
› Login from the Online menu to download the required run libs
  – Before..make sure you ticked "Simulation"!

› Now, we're ready to go



Run workbench

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



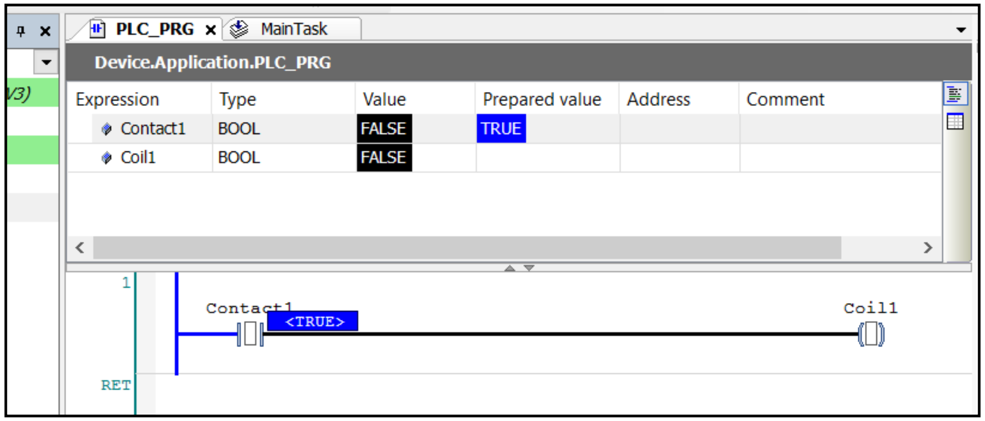
Expression	Type	Value	Pre
Contact1	BOOL	FALSE	
Coil1	BOOL	FALSE	

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)



Expression	Type	Value	Prepared value	Address	Comment
Contact1	BOOL	FALSE	TRUE		
Coil1	BOOL	FALSE			

› 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

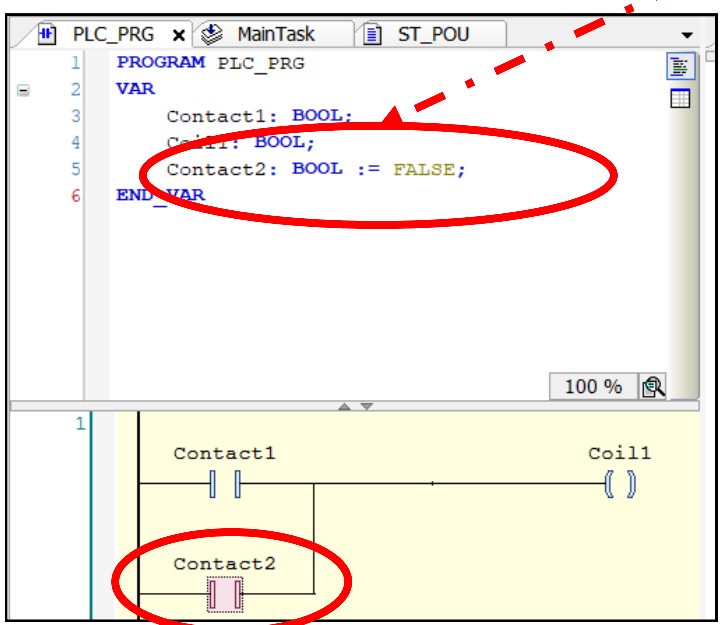
Logical “AND”

- ..easy, simply drag&drop

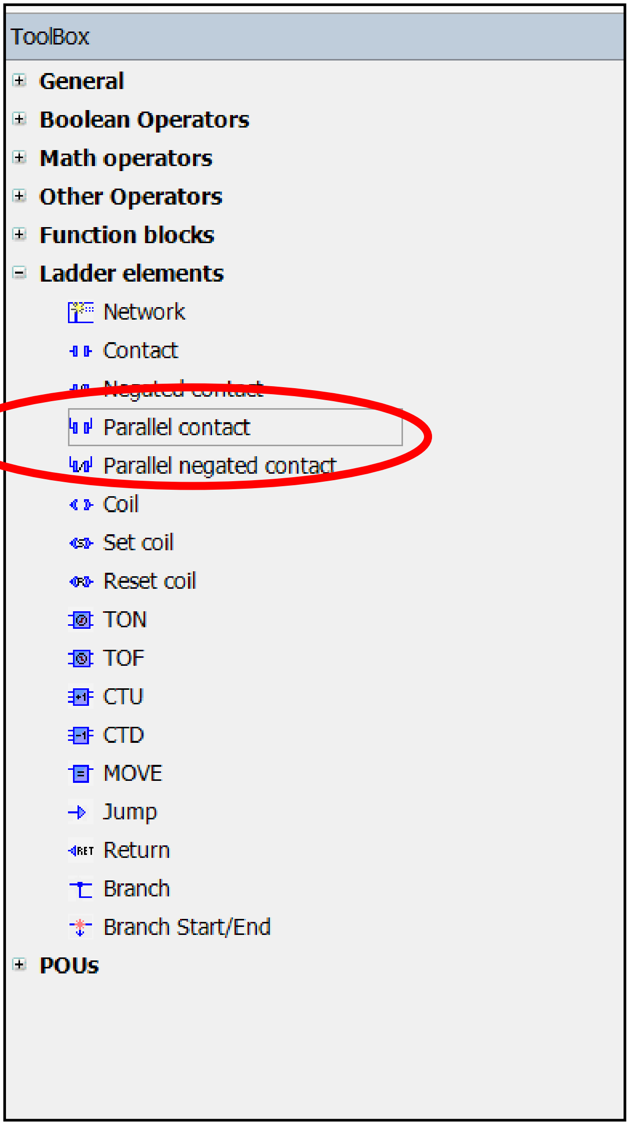
Logical “OR”

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

PS good programmers remember to initialize vars ;)



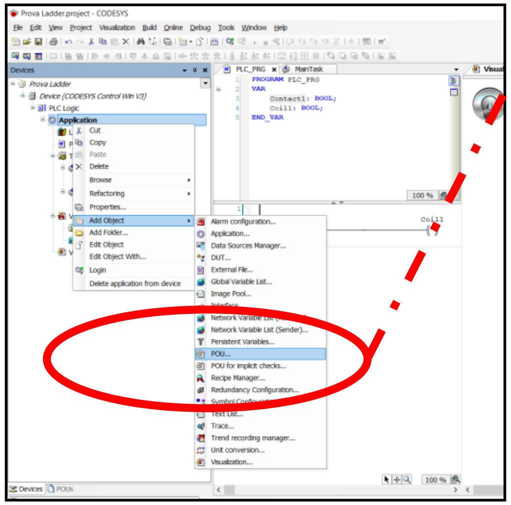
```
PROGRAM PLC_PRG
VAR
    Contact1: BOOL;
    Coil1: BOOL;
    Contact2: BOOL := FALSE;
END_VAR
```



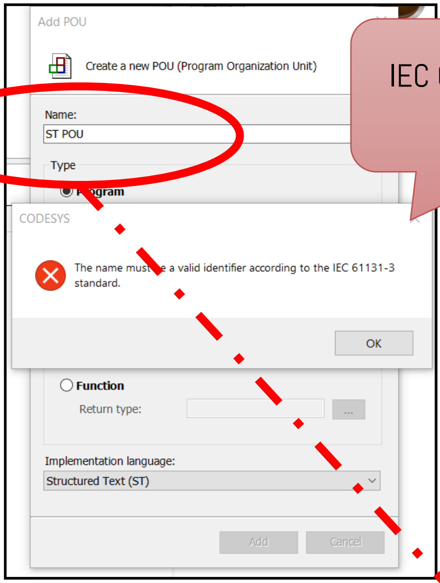
Structured Text

Add new ST POU

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



```
PROGRAM PLC_PRG
VAR
    Contact1: BOOL;
    Coil1: BOOL;
END_VAR
```



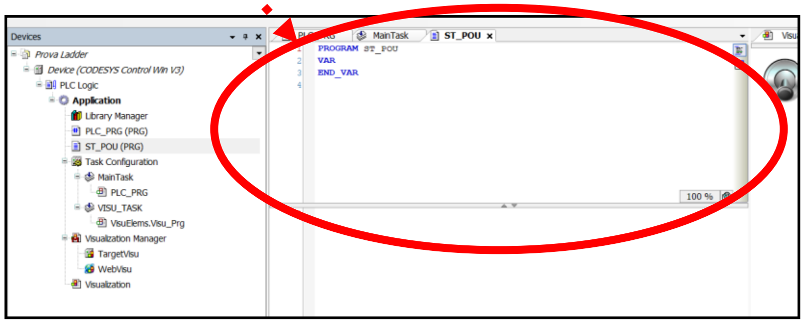
Name: ST POU

Type: Program

Implementation language: Structured Text (ST)

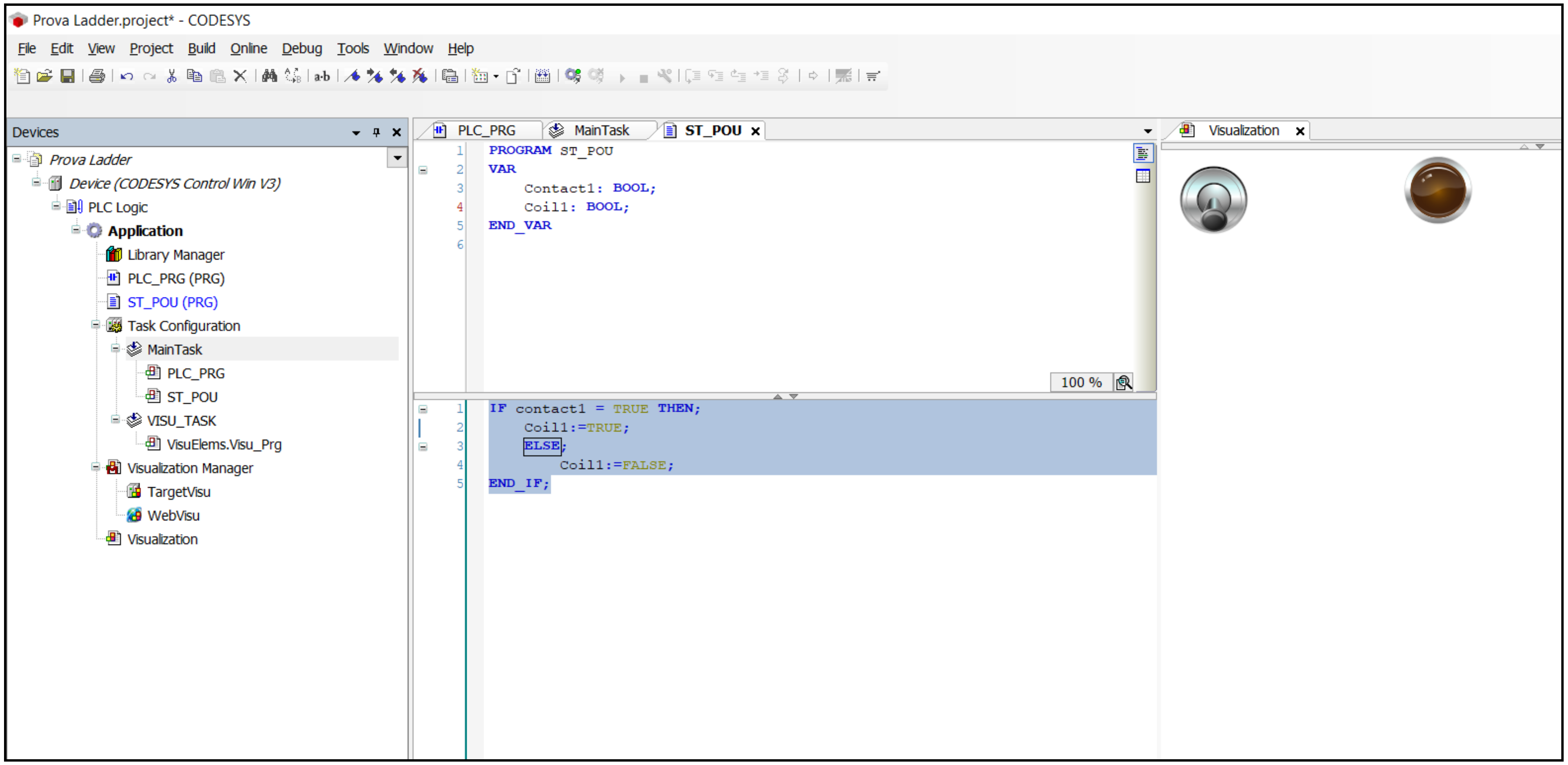
The name must be a valid identifier according to the IEC 61131-3 standard.

IEC 61131 does not allow spaces in names



```
PROGRAM ST_POU
VAR
END_VAR
```

Write the ST code



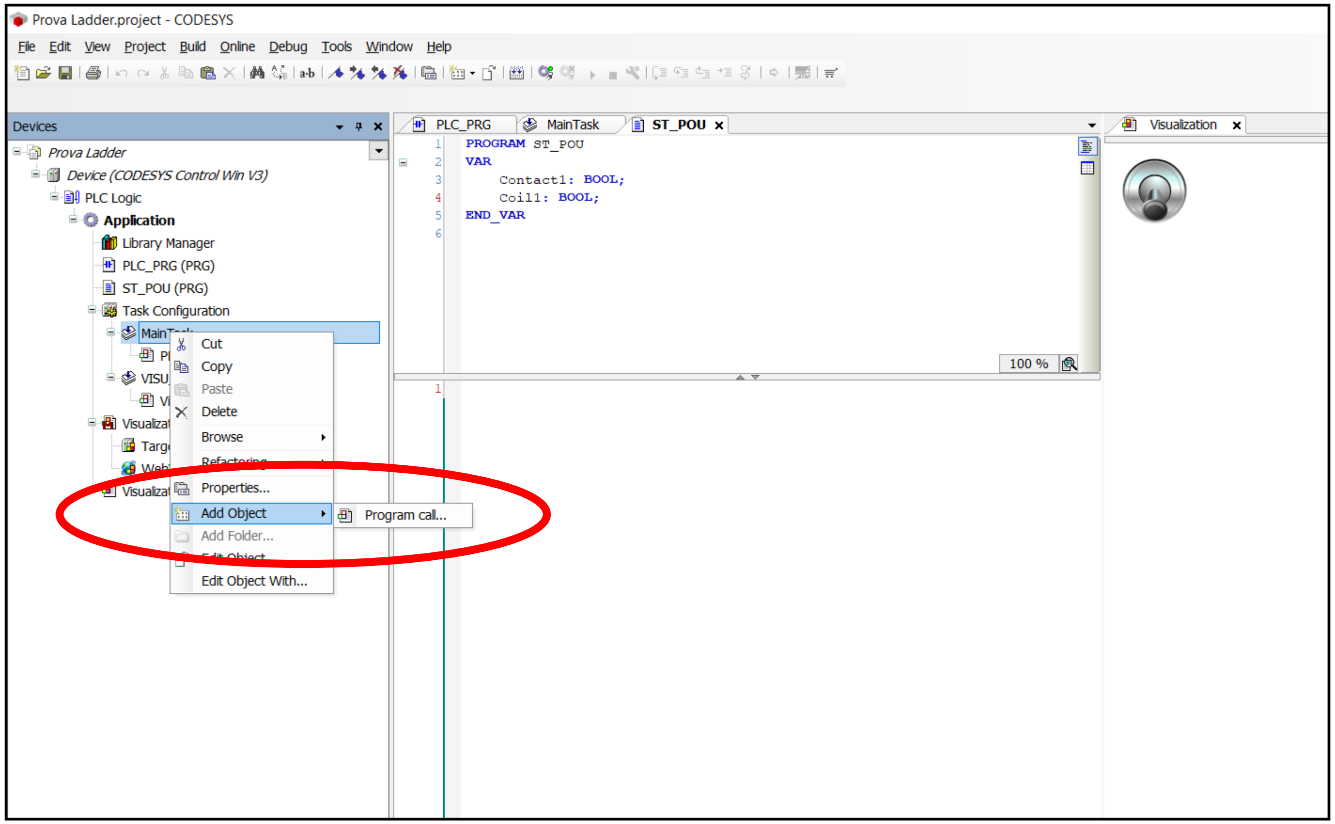
Prova Ladder.project* - CODESYS

```
PROGRAM ST_POU
VAR
    Contact1: BOOL;
    Coil1: BOOL;
END_VAR
```

```
IF contact1 = TRUE THEN;
    Coil1:=TRUE;
    ELSE;
        Coil1:=FALSE;
END_IF;
```

Are we done? Not yet...

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



```
PROGRAM ST_POU
VAR
    Contact1: BOOL;
    Coil1: BOOL;
END_VAR
```

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…

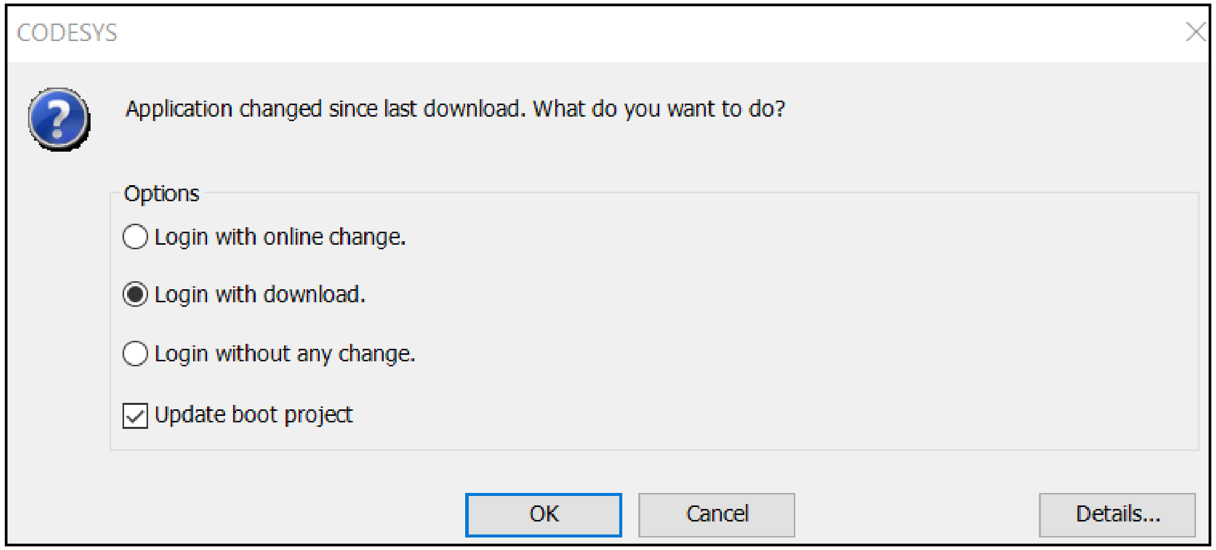
Should we attach those vars to the two simulated objects?

- (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



CODESYS

Application changed since last download. What do you want to do?

Options

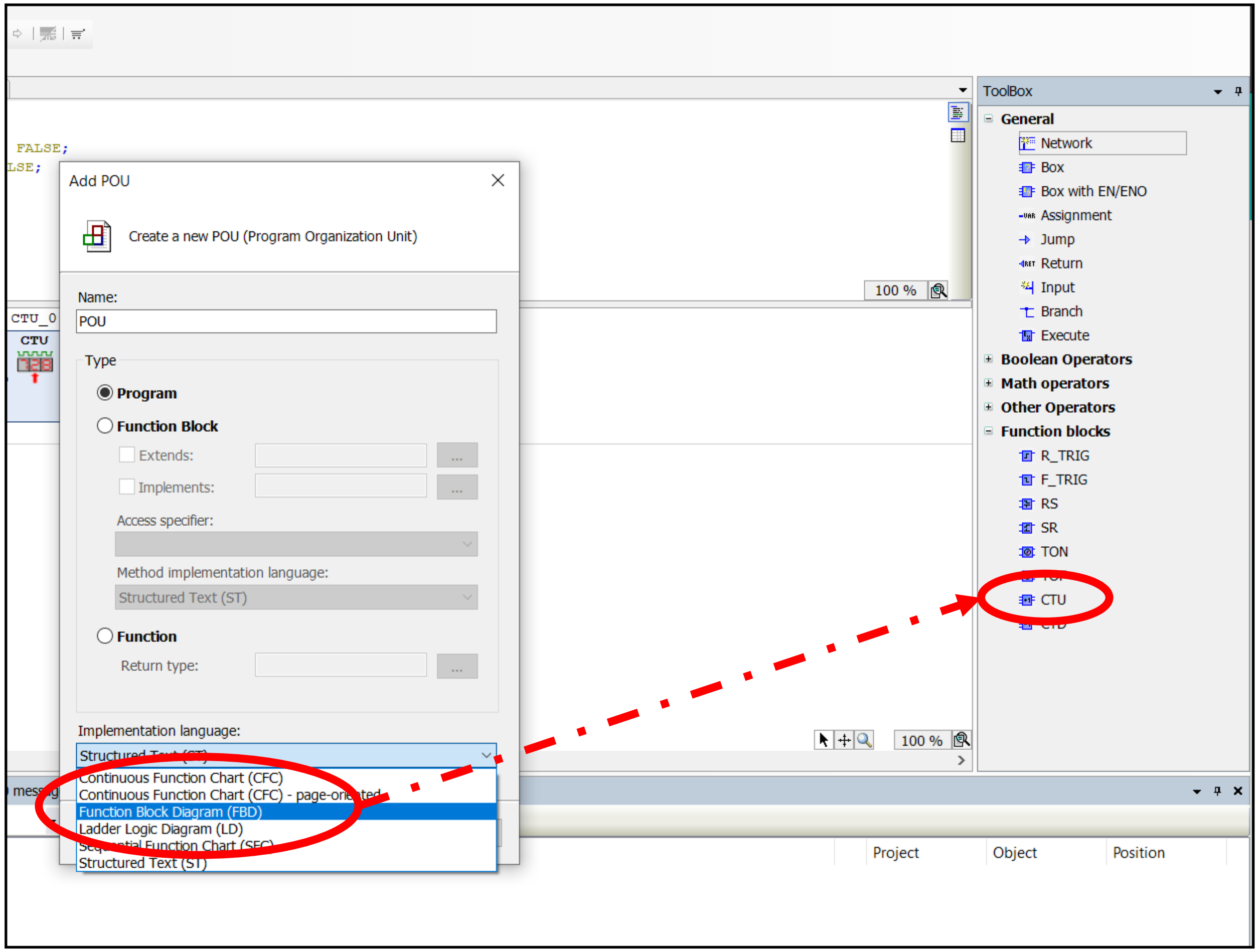
- ○ Login with online change.
- ● Login with download.
- ○ Login without any change.
- ☑ Update boot project

Programming with Function Blocks

Counters - CTU

› Create a program, or add a POU of type "FBD"

› Then, drag a Counter (CTU) in the workbench



Add POU

Create a new POU (Program Organization Unit)

Name: POU

Type

[✓ Program]

Function Block

Extends:

Implements:

Access specifier:

Method implementation language: Structured Text (ST)

Function

Return type:

Implementation language: Structured Text (ST)

- Continuous Function Chart (CFC)
- Continuous Function Chart (CFC) - page-oriented
- [✓ Function Block Diagram (FBD)]
- Ladder Logic Diagram (LD)
- Sequential Function Chart (SFC)
- Structured Text (ST)

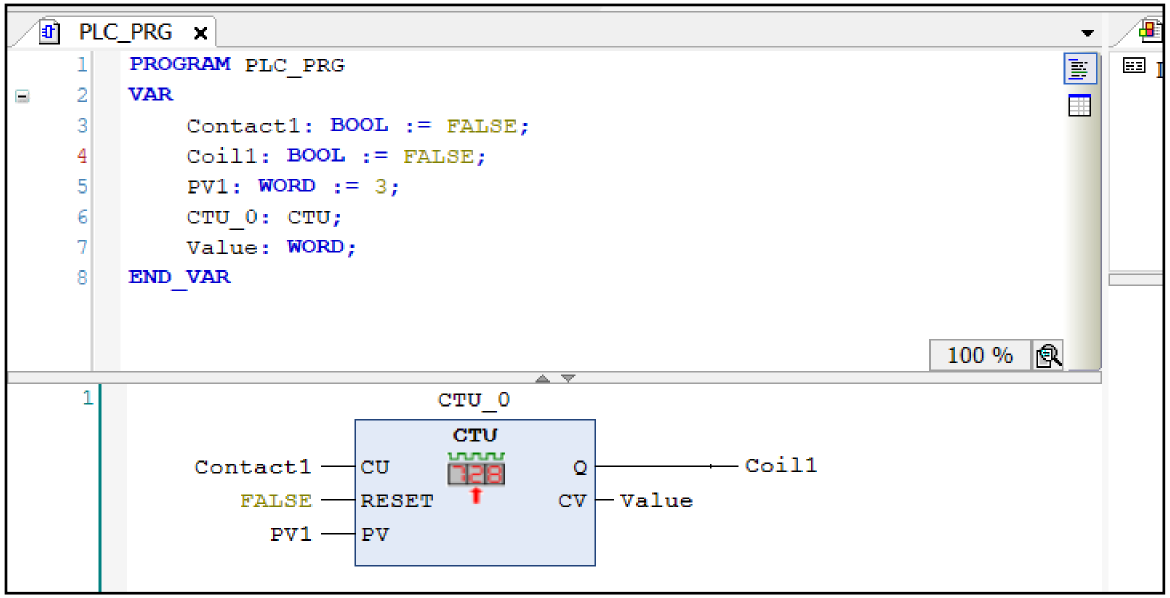
ToolBox

- General
  - Network
  - Box
  - Box with EN/ENO
  - Assignment
  - Jump
  - Return
  - Input
  - Branch
  - Execute
- Boolean Operators
- Math operators
- Other Operators
- Function blocks
  - R_TRIG
  - F_TRIG
  - RS
  - SR
  - TON
  - TOF
  - [✓ CTU]
  - CTD

Bind the CTU

Connect CTU in&outs to vars

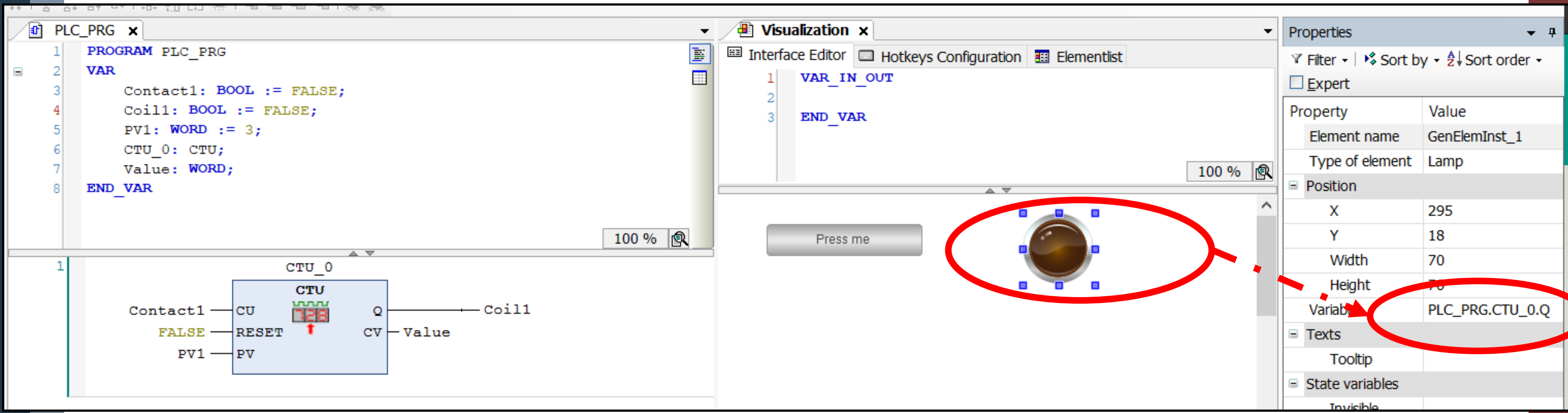
- CU to a contact (press&hold button)
- Here, RESET is false (just for this example)..might use a button/contact?
- PV1 is a WORD
- Q to a coil (we want to turn on a lamp)
- CV to a WORD variable, to monitor the status



```
PROGRAM PLC_PRG
VAR
    Contact1: BOOL := FALSE;
    Coil1: BOOL := FALSE;
    PV1: WORD := 3;
    CTU_0: CTU;
    Value: WORD;
END_VAR
```

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`



```
PROGRAM PLC_PRG
VAR
    Contact1: BOOL := FALSE;
    Coil1: BOOL := FALSE;
    PV1: WORD := 3;
    CTU_0: CTU;
    Value: WORD;
END_VAR
```

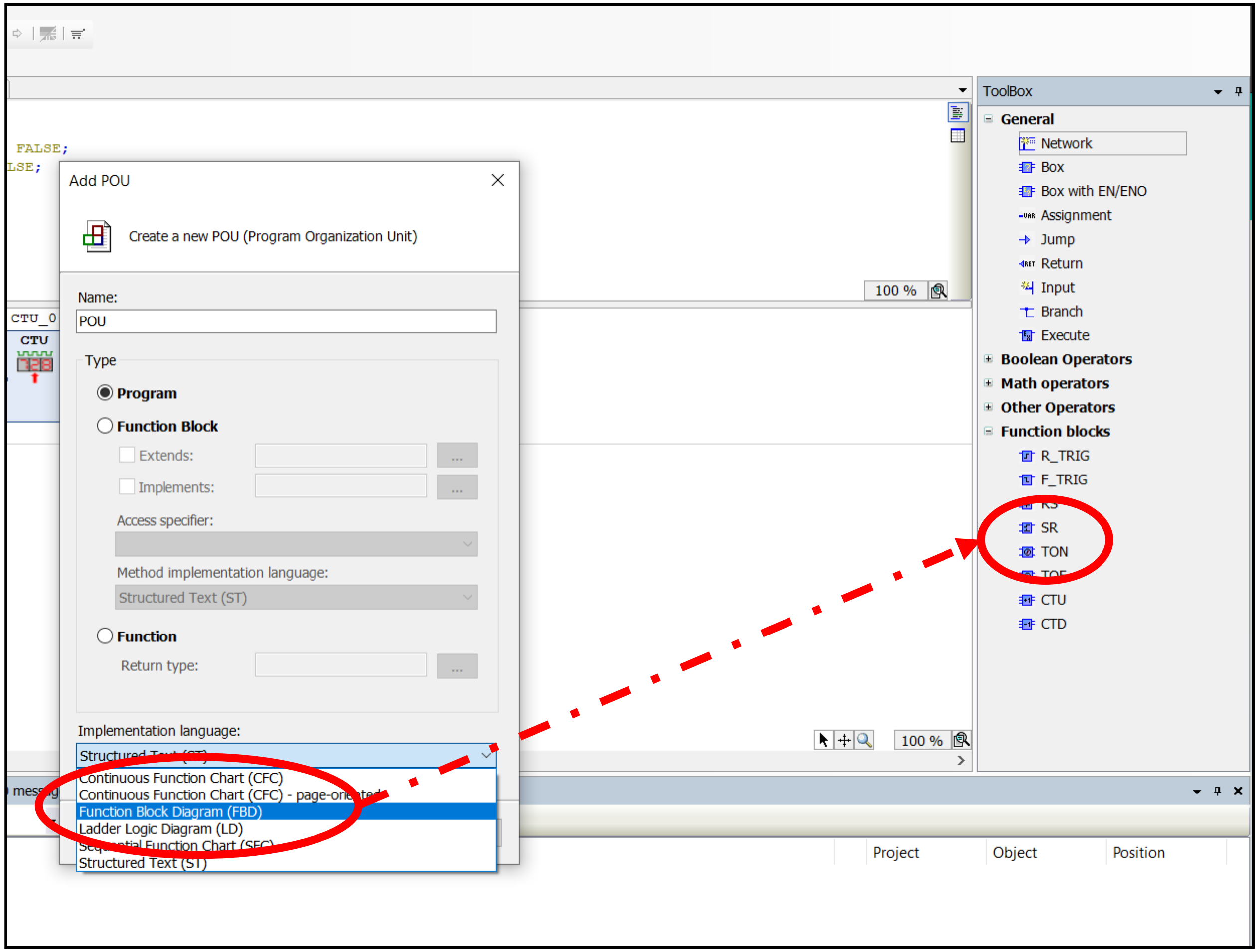
```
VAR_IN_OUT

END_VAR
```

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	
Invisible	

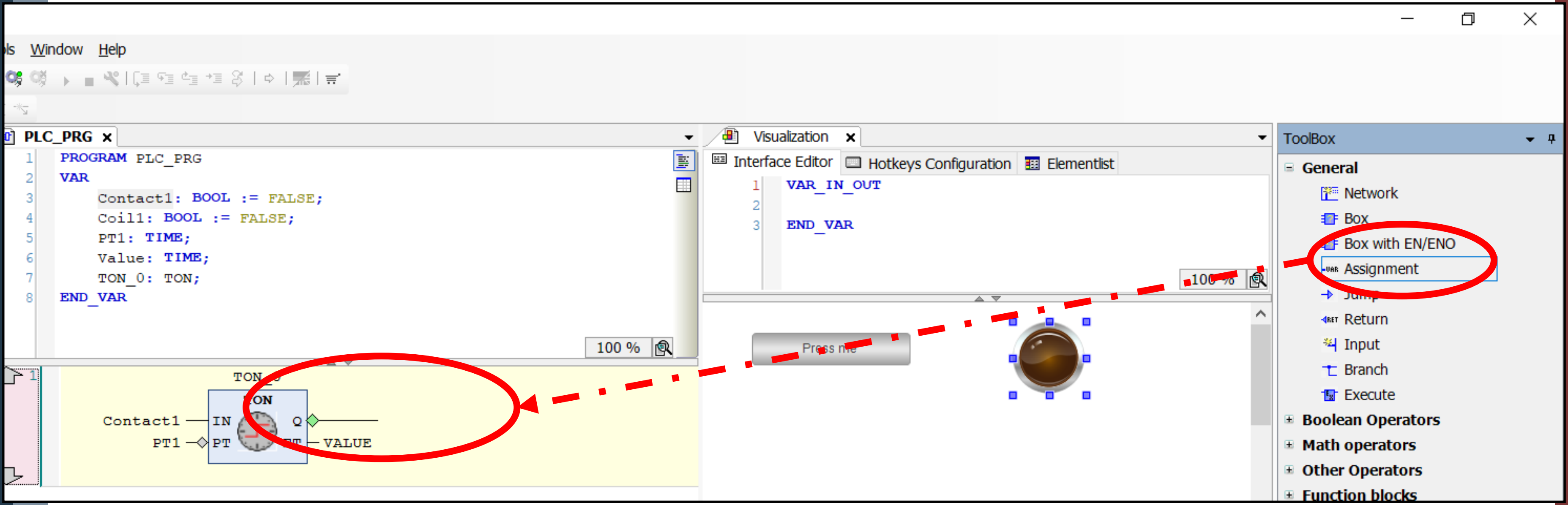
Timers – TON

- 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



```
PROGRAM PLC_PRG
VAR
    Contact1: BOOL := FALSE;
    Coil1: BOOL := FALSE;
    PT1: TIME;
    Value: TIME;
    TON_0: TON;
END_VAR
```

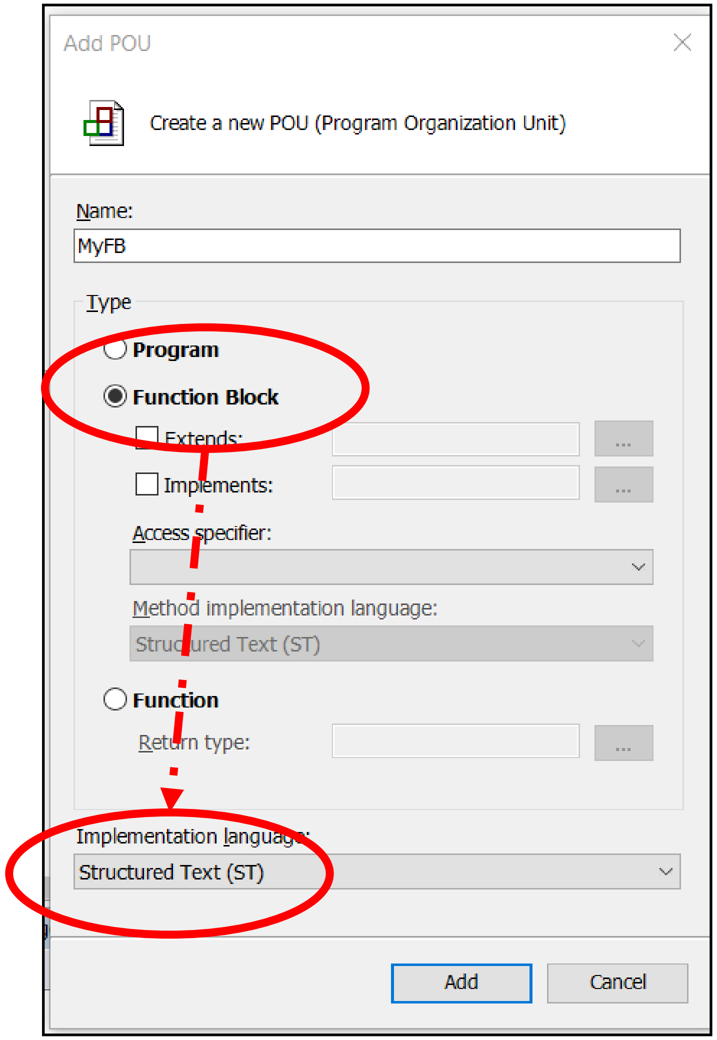
```
VAR_IN_OUT

END_VAR
```

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)

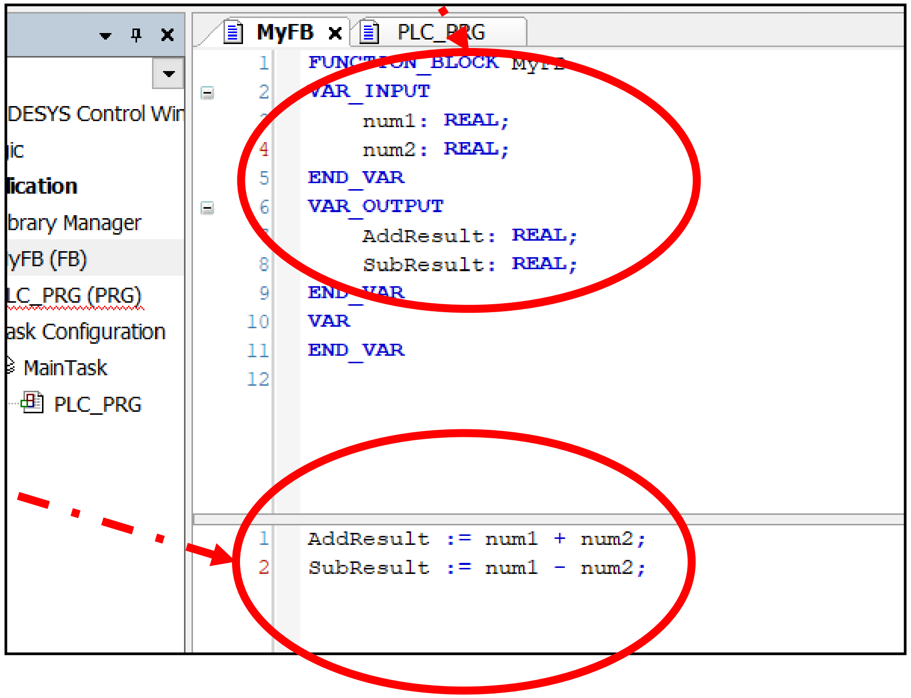
Implement the Function Block

Add in/out vars

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

Add FB logics

- In ST workbench



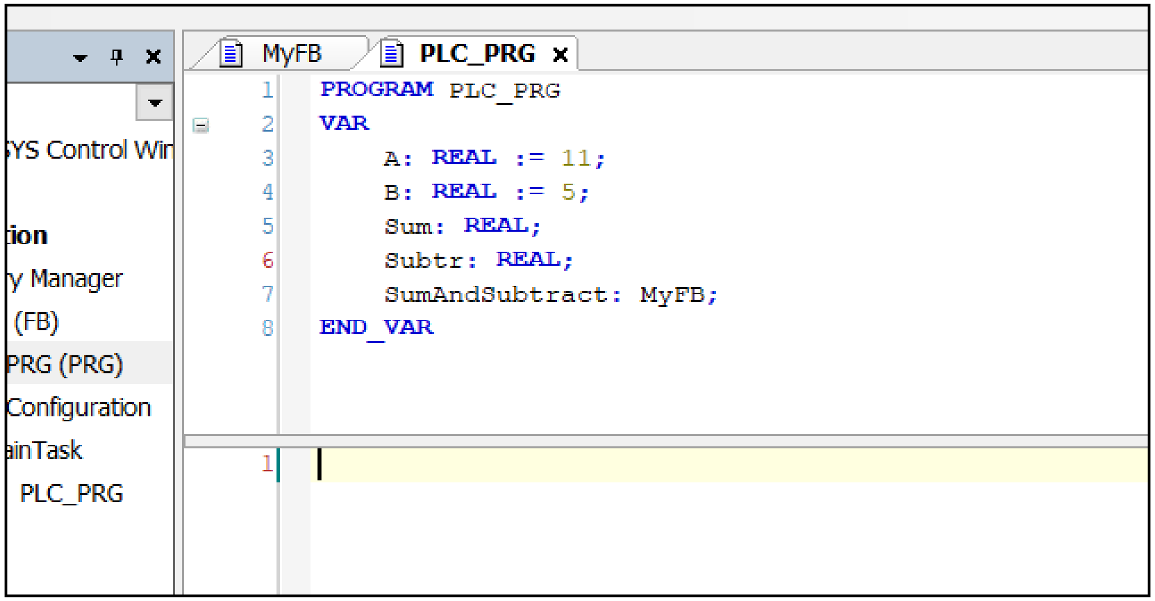
```
FUNCTION_BLOCK MyFB
VAR_INPUT
    num1: REAL;
    num2: REAL;
END_VAR
VAR_OUTPUT
    AddResult: REAL;
    SubResult: REAL;
END_VAR
VAR
END_VAR
```

```
AddResult := num1 + num2;
SubResult := num1 - num2;
```

Use it in the Application

In the main POU, create vars

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



```
PROGRAM PLC_PRG
VAR
    A: REAL := 11;
    B: REAL := 5;
    Sum: REAL;
    Subtr: REAL;
    SumAndSubtract: MyFB;
END_VAR
```

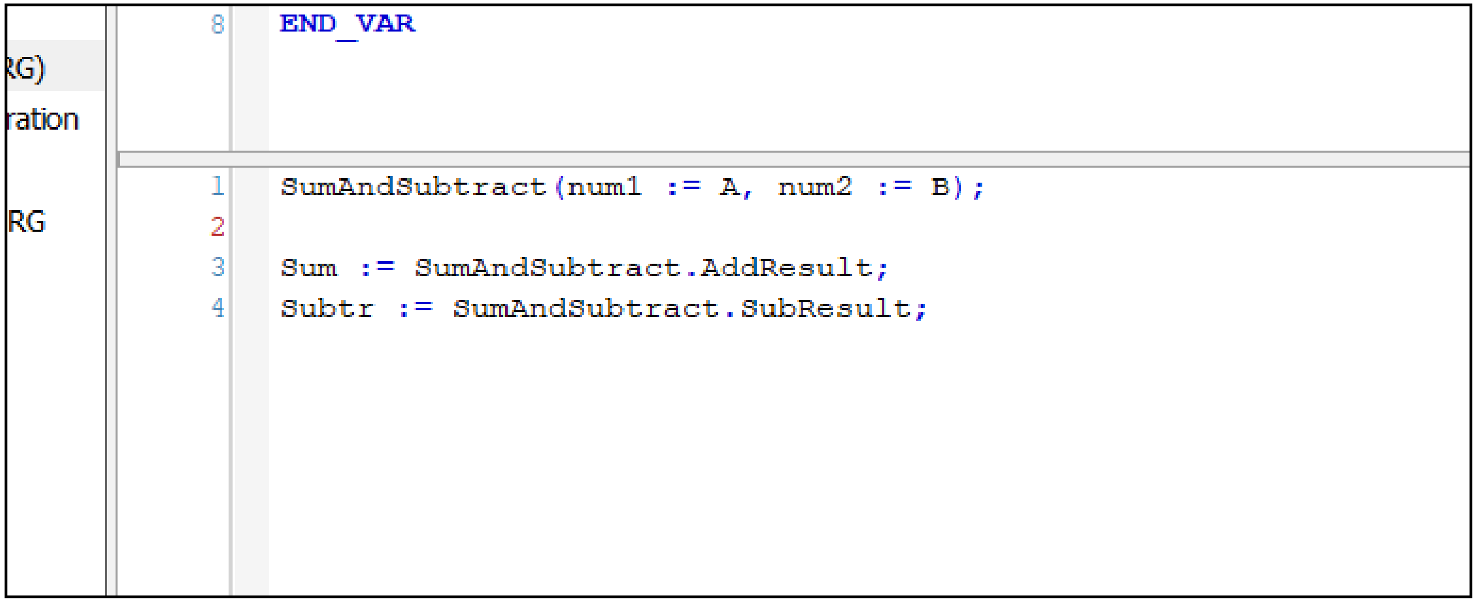
Call the FB from application

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?

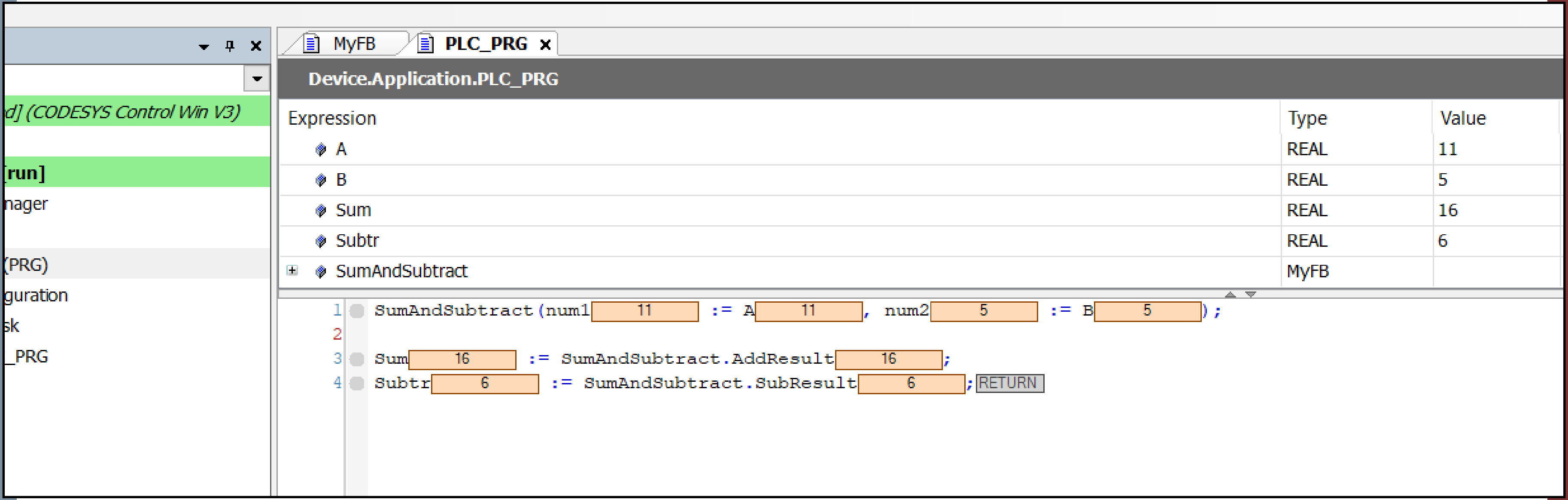


```
END_VAR
```

```
SumAndSubtract(num1 := A, num2 := B);

Sum := SumAndSubtract.AddResult;
Subtr := SumAndSubtract.SubResult;
```

Simulate..and enjoy! ☺


d] (CODESYS Control Win V3)

[run]

nager

(PRG)

guration

sk

_PRG

MyFB | PLC_PRG

Device.Application.PLC_PRG

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

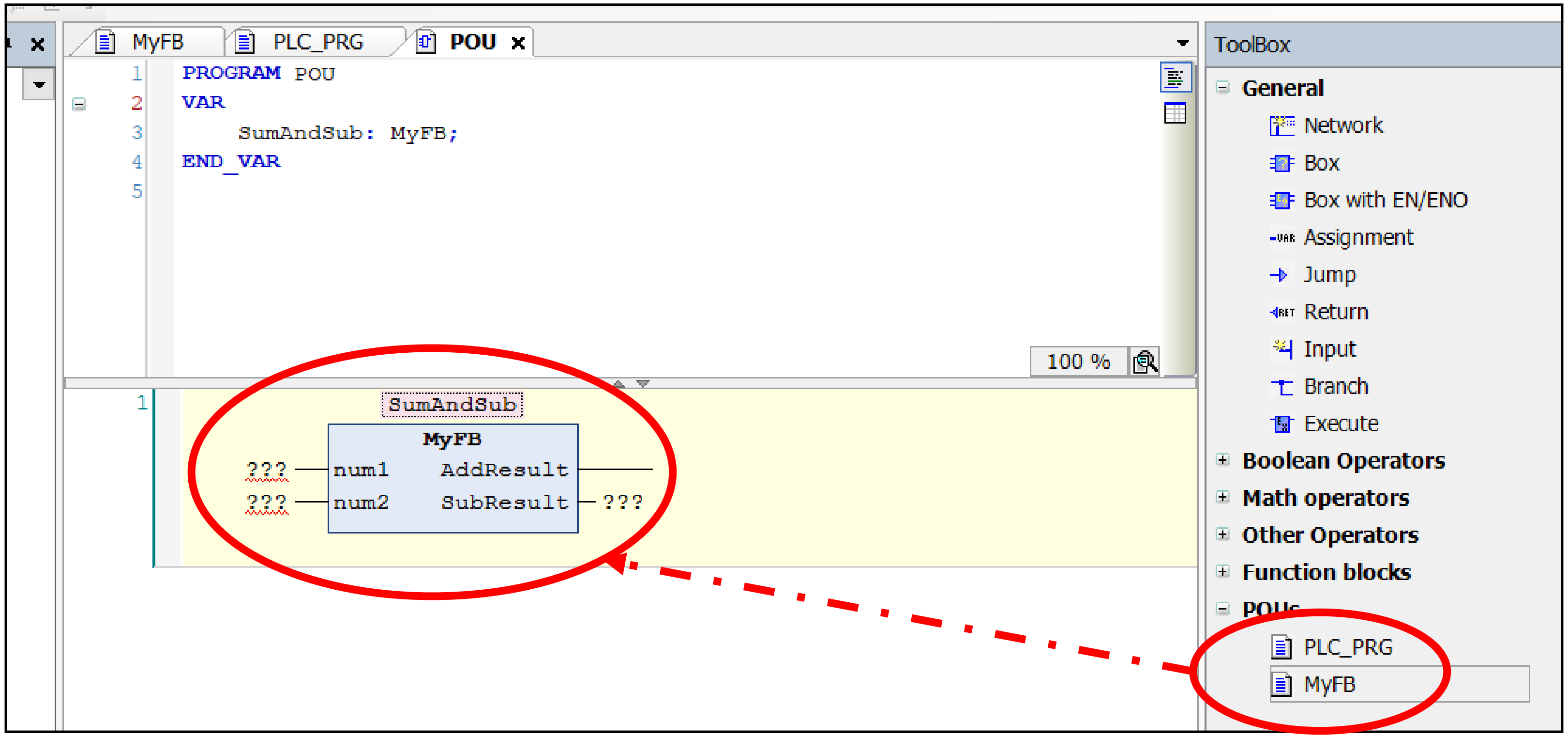
```
SumAndSubtract(num1 11 := A 11 , num2 5 := B 5 );

Sum 16 := SumAndSubtract.AddResult 16 ;
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!



```
PROGRAM POU
VAR
    SumAndSub: MyFB;
END_VAR
```

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 POUs

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