# PLC User Manual of Schneider Electric

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Jan 21

https://tharotk-phd.notion.site/PLC-User-Manual-of-Schneider-Electric-abd0736a13d94603a81bc43b100669bf

| ***Objectives*** |
| --- |
| *Understand the communication between PLC and HMI/SCADA* |
| *Implement and observe communication flows* |
| *Analyze the flows and optimize the communication* |

# Architecture

-CPU
-Network Interface

## PLC (Programmable Logic Controller)

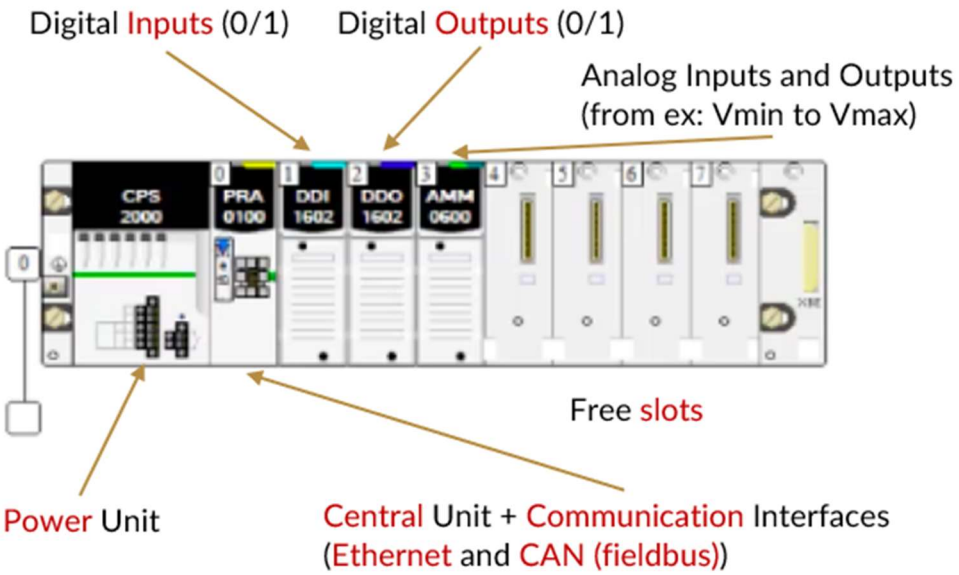



Figure 1: PLC architecture including: Power Unit; Central Unit+ Communication Interfeces; Digital Input/Digital Output; Analog Input/Analog Output

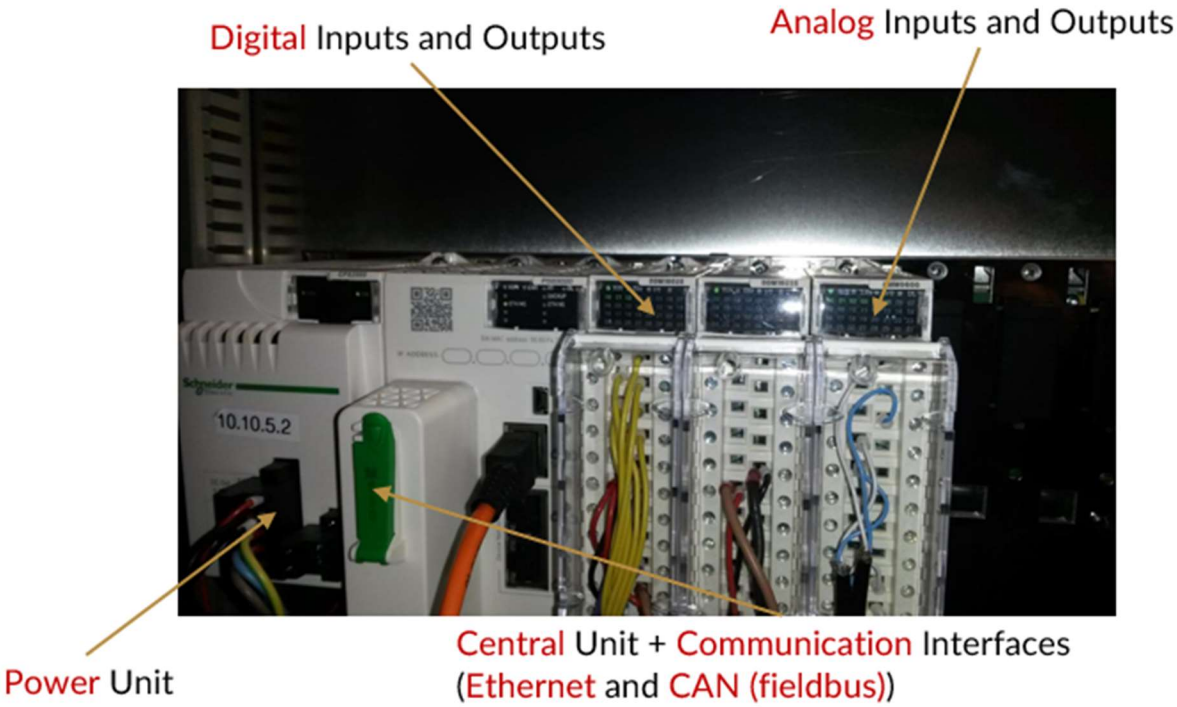


Figure 2: Schneider PLC architecture of including: Power Unit; Central Unit+ Communication Interfeces; Digital Input/Digital Output; Analog Input/Analog Output

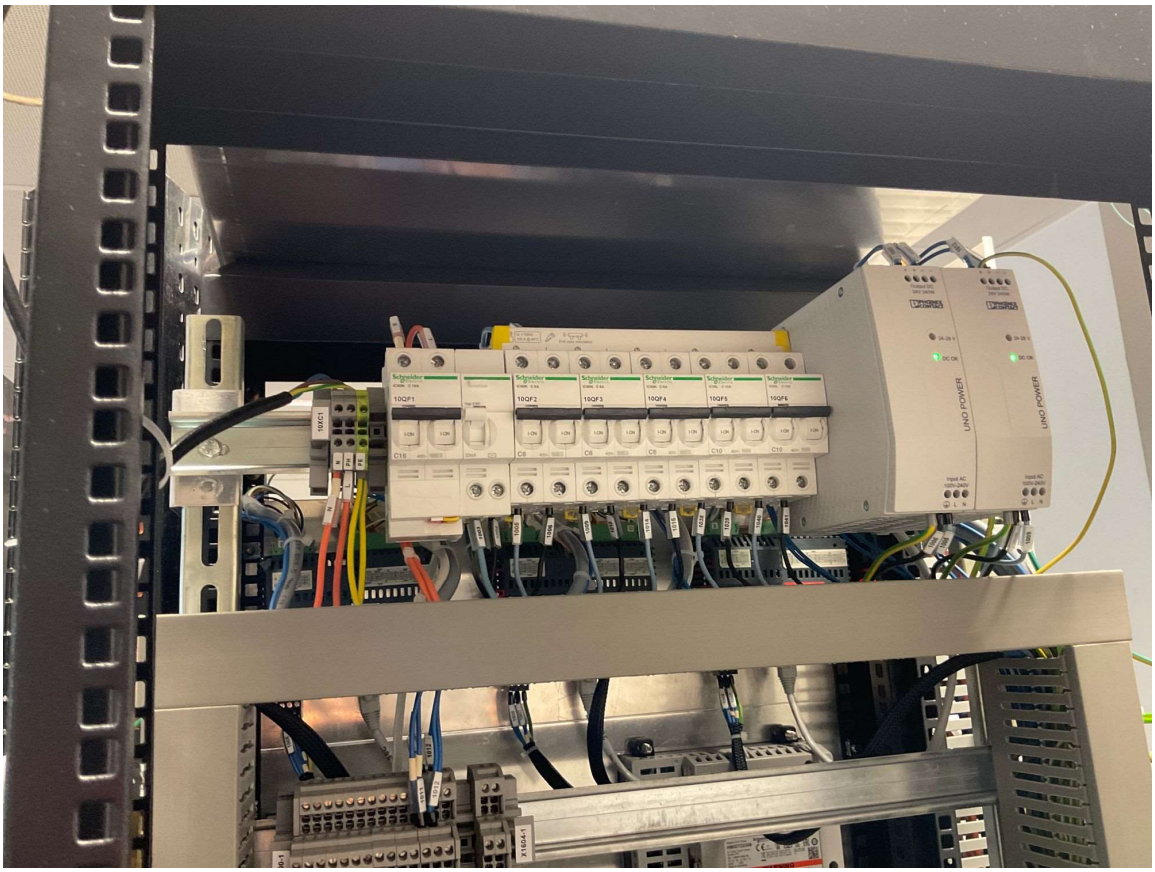
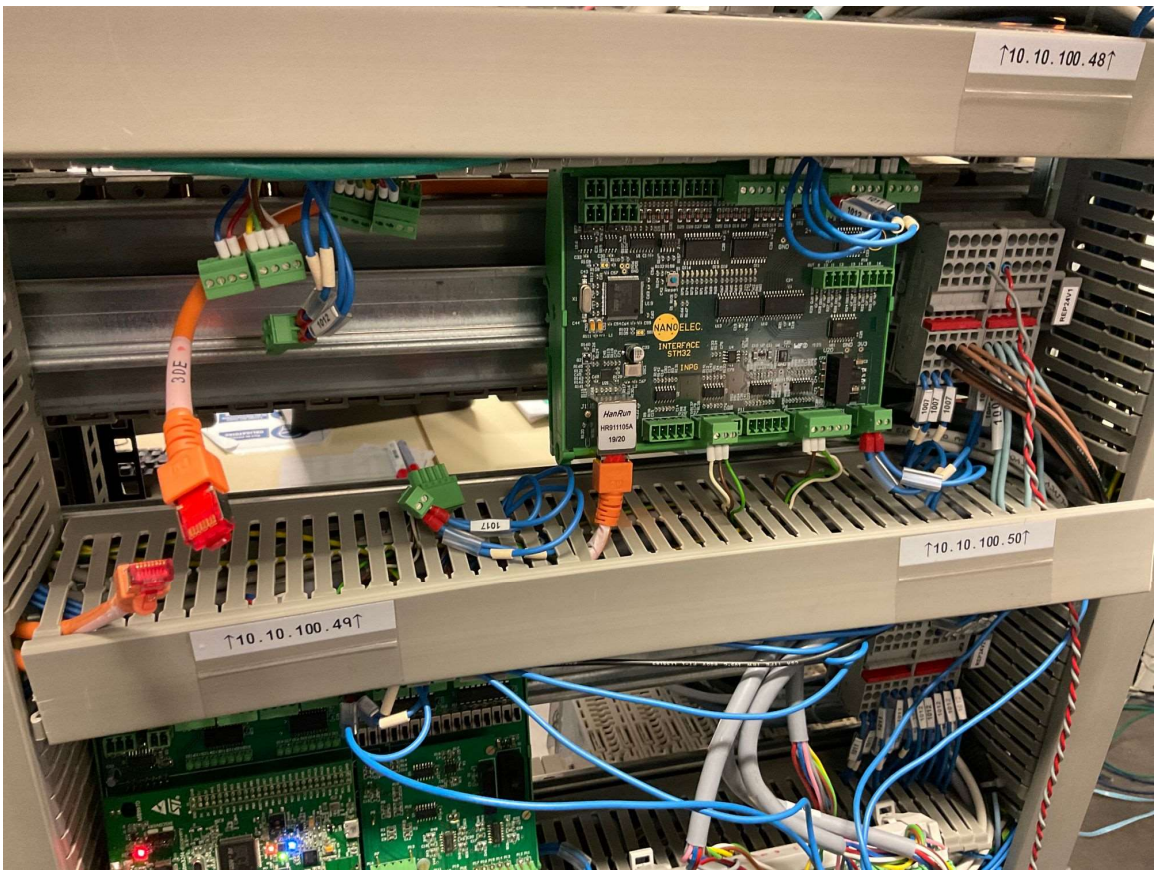


Figure 3: Schneider PLC architecture

# The simulation card

There are some connections between the architecture and I/O with the simulation card



# Getting Started to create a project

Developing an application using Unity Pro XL involves creating a project associated with a PLC

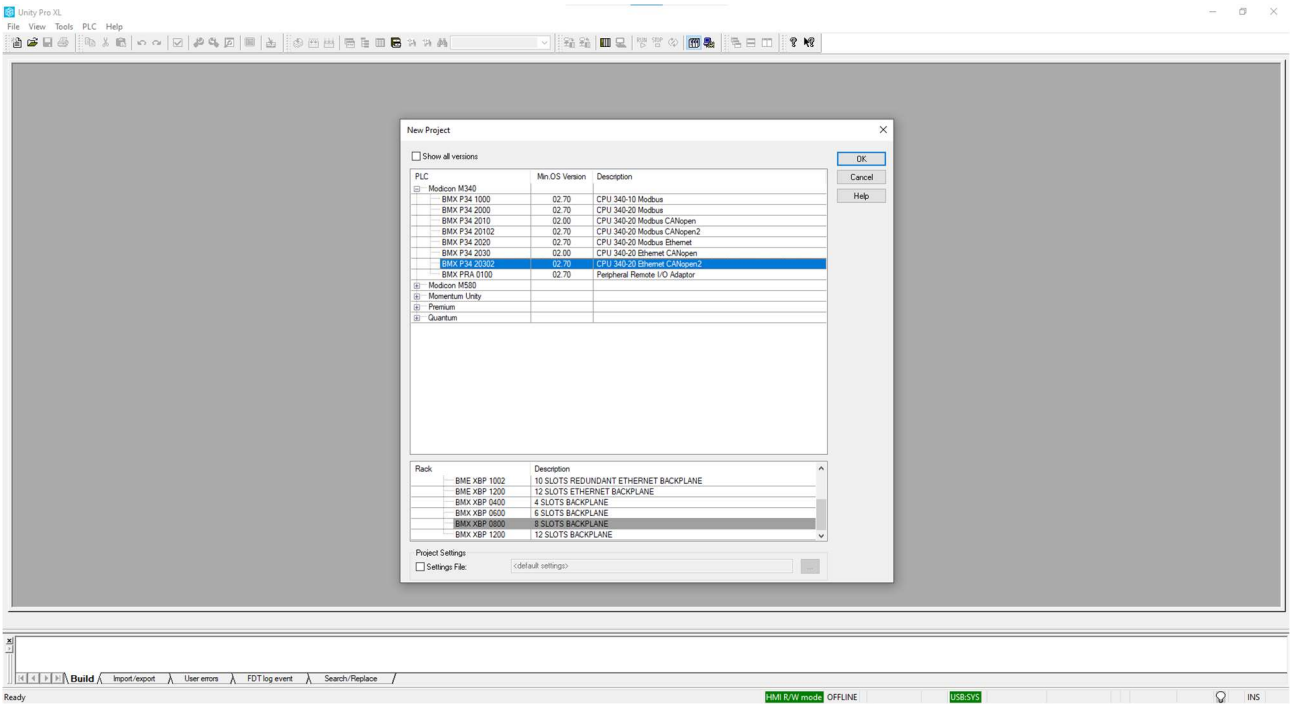



Figure 4: New Project>BMX P34 20302 in Modicon M340

Launch the Unity Pro software

Click on File then New then select a PLC

Insert a module “BMX P34 20302 in Modicon M340”

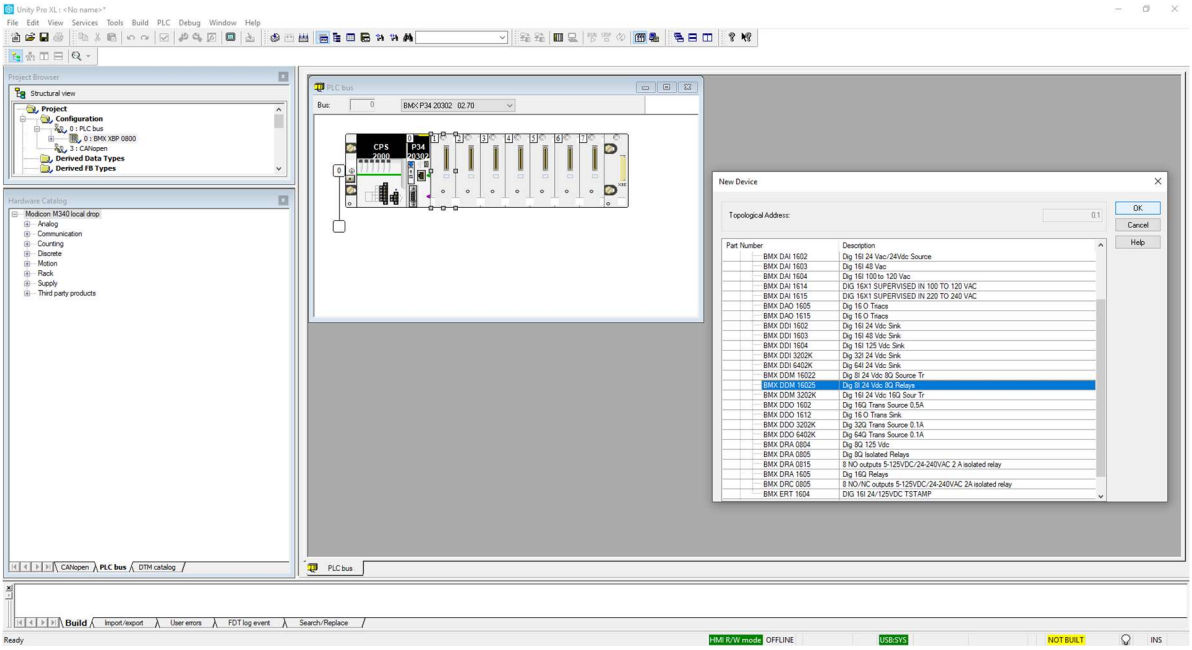



Figure 5: BMX DDM 16025

Click configuration/PLC bus

Double click at P34 20302

Select BMX DDM 16025

Click OK

# Network Configuration

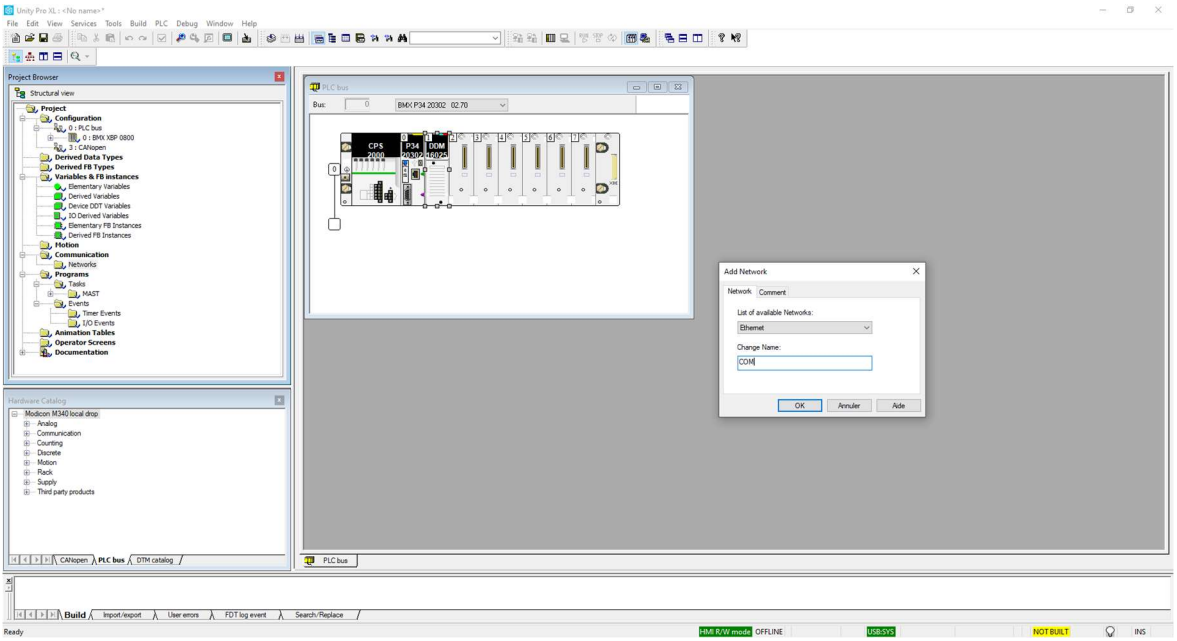



Figure 6:

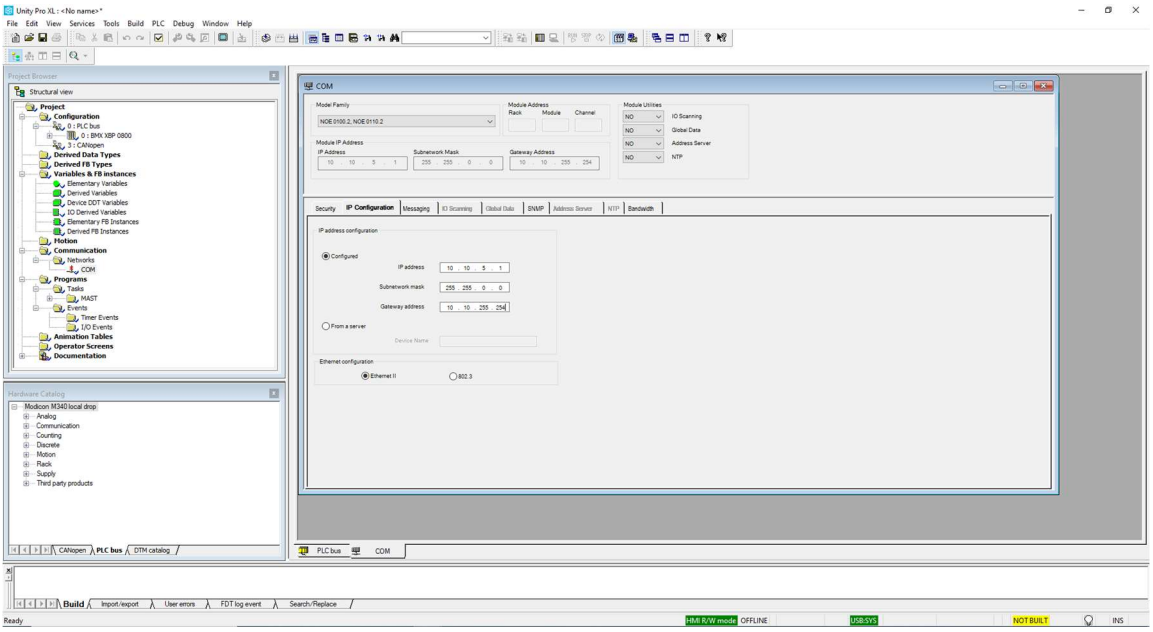



Figure 7:

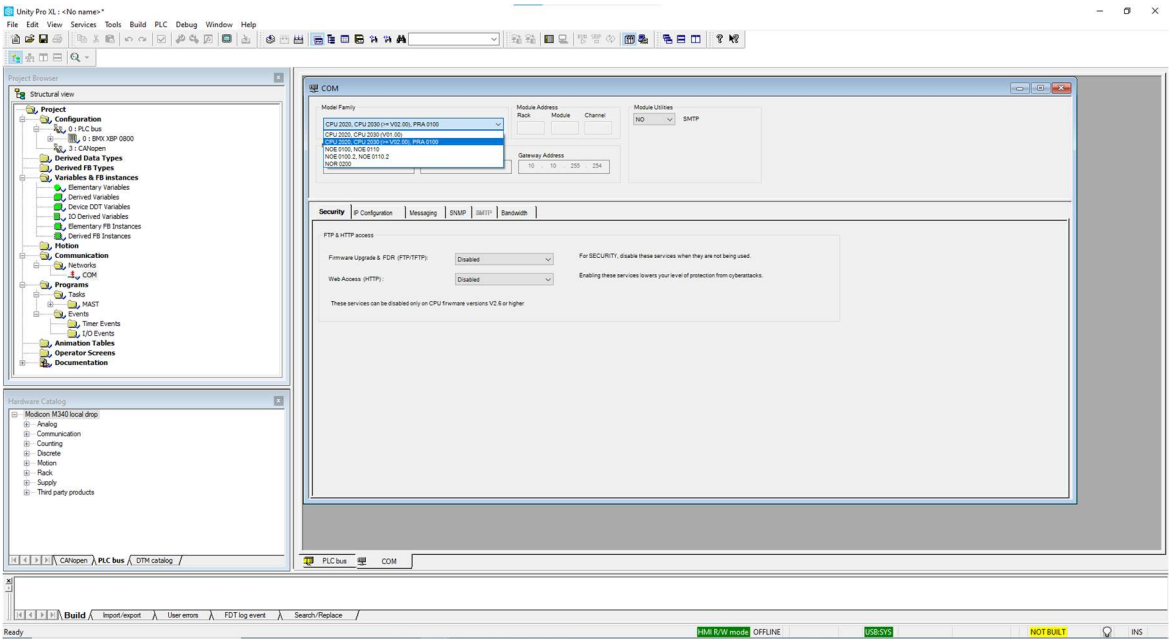



Figure 8:

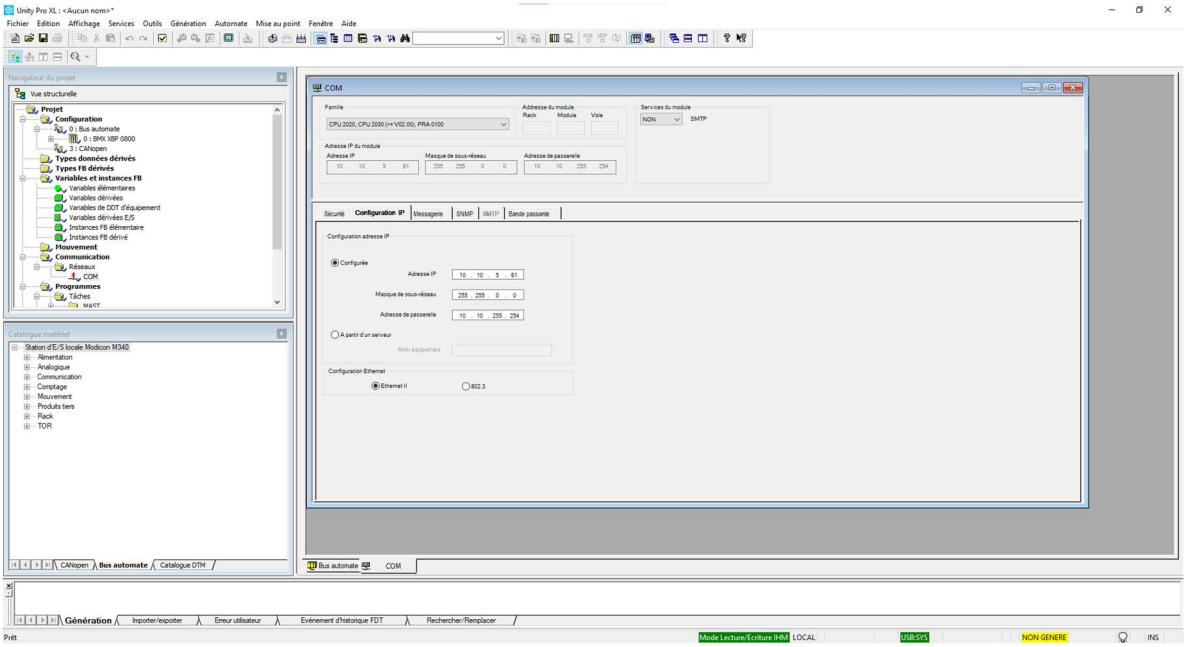



Figure 9:

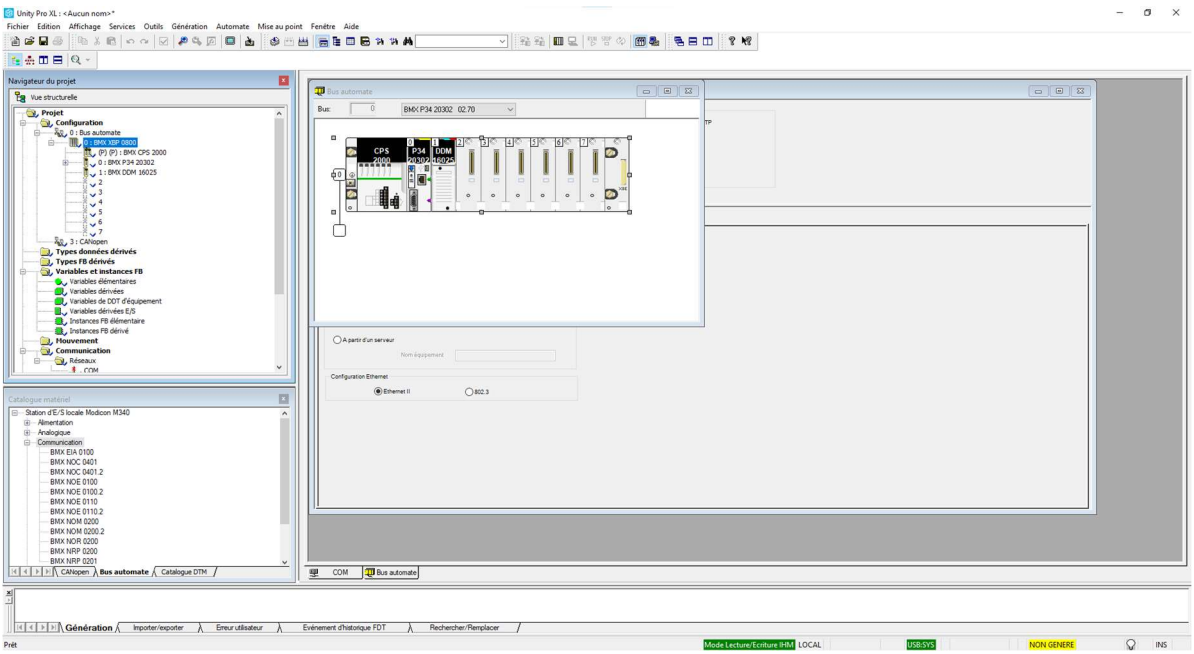



Figure 10:

# I/O Configuration

Programming should be in a physical because the rack is here in the lab

In real industry, they will put in the box and configure from the program here

How to program this architecture/devices

How to send I/O

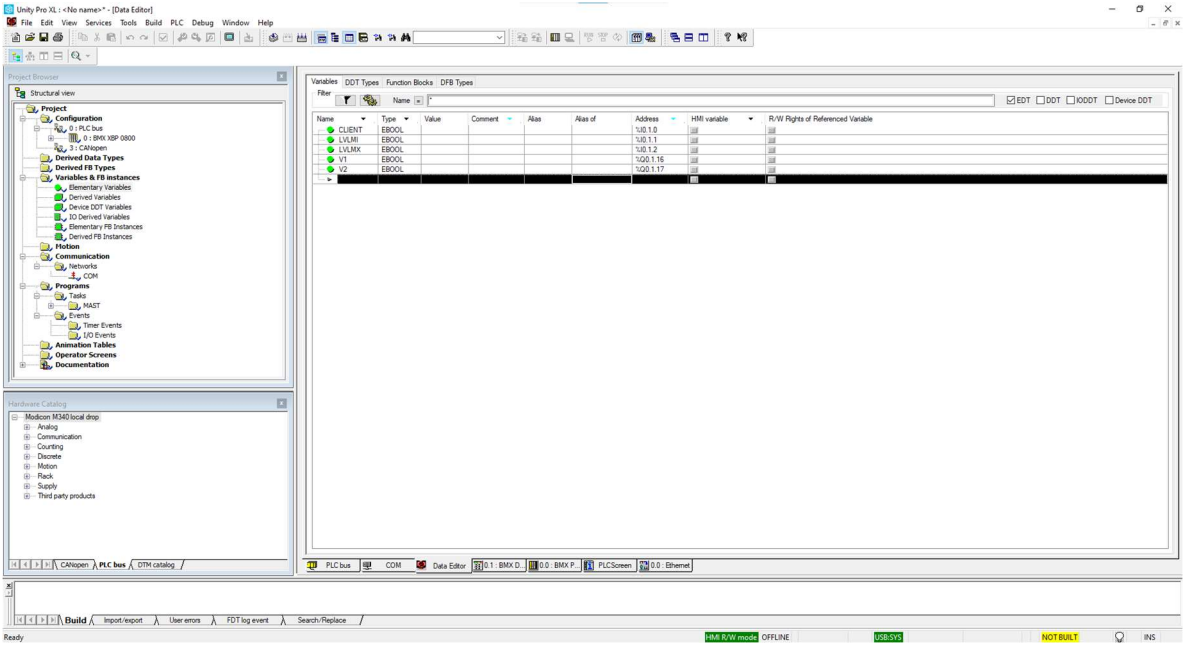


Figure 11:

Click Elementary Variables

Insert Input and Output variables as Figure 12 and Figure 13

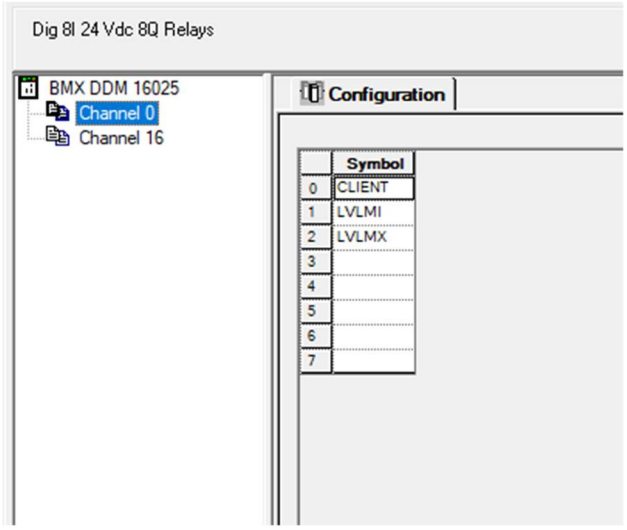



Figure 12: Input

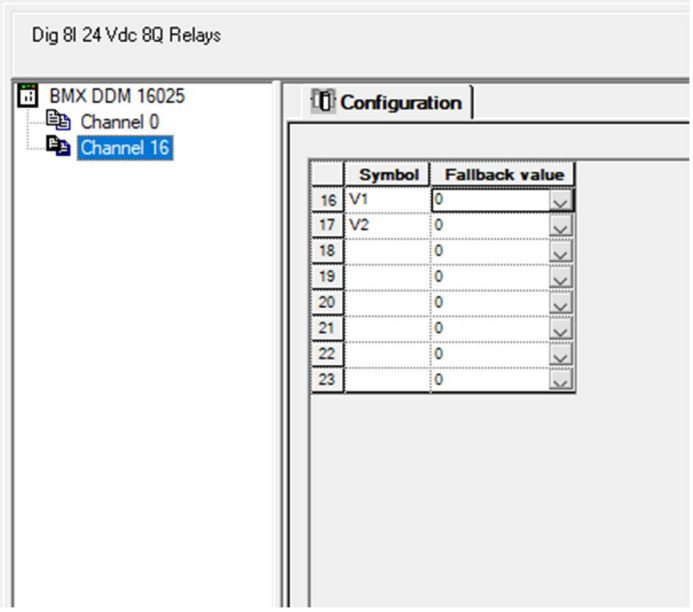


Figure 13: Output

# Programming Languages

What is the purpose of the PLC

To program, how many languages of this PLC

Taking accounts of the I/O

**PLC Languages: IEC 61131**

**Instruction list (IL)**

**Ladder Diagram (LD)**

**Function Block Diagram (FBD)**

**Structured Text (ST)**

**Sequential Flow Chart (SFC)**

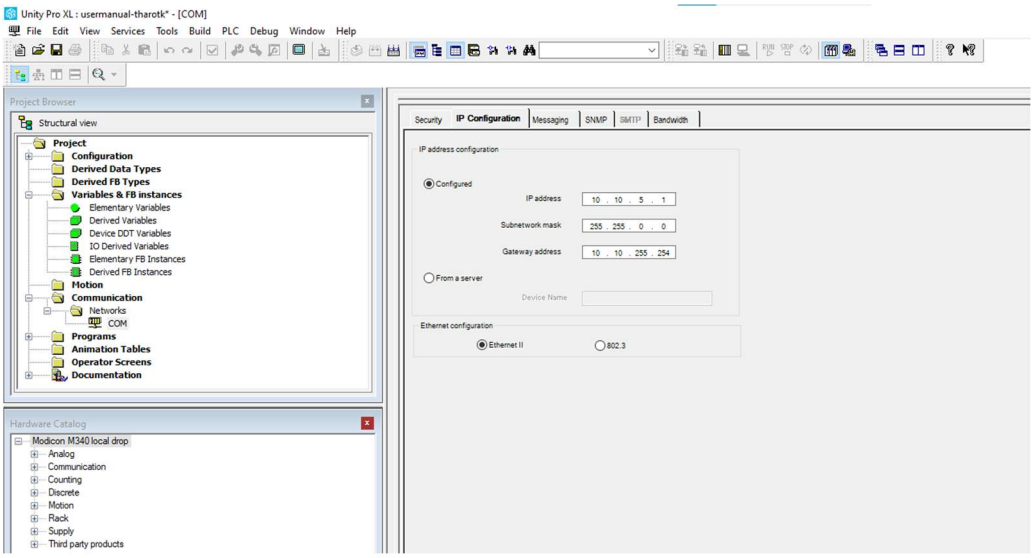
# Compiler

What does it mean to compile?

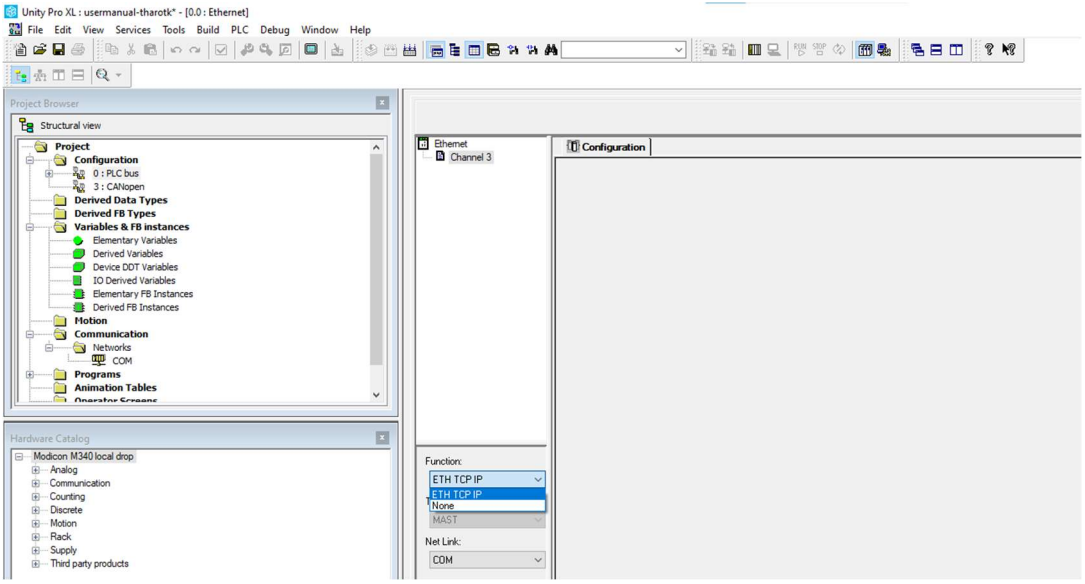
we write the program in the PLC languages and it will send to the PLC

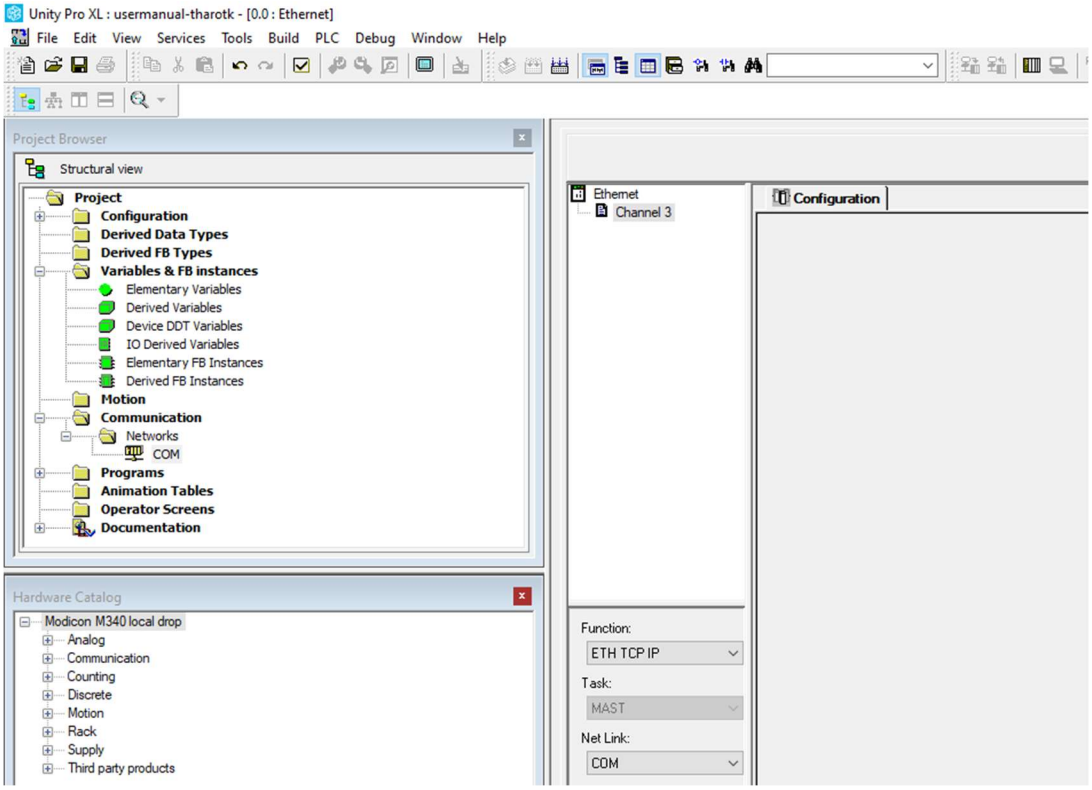
How has it done in Schneider?

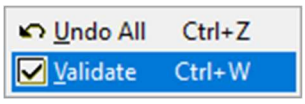
Connection with the PLC

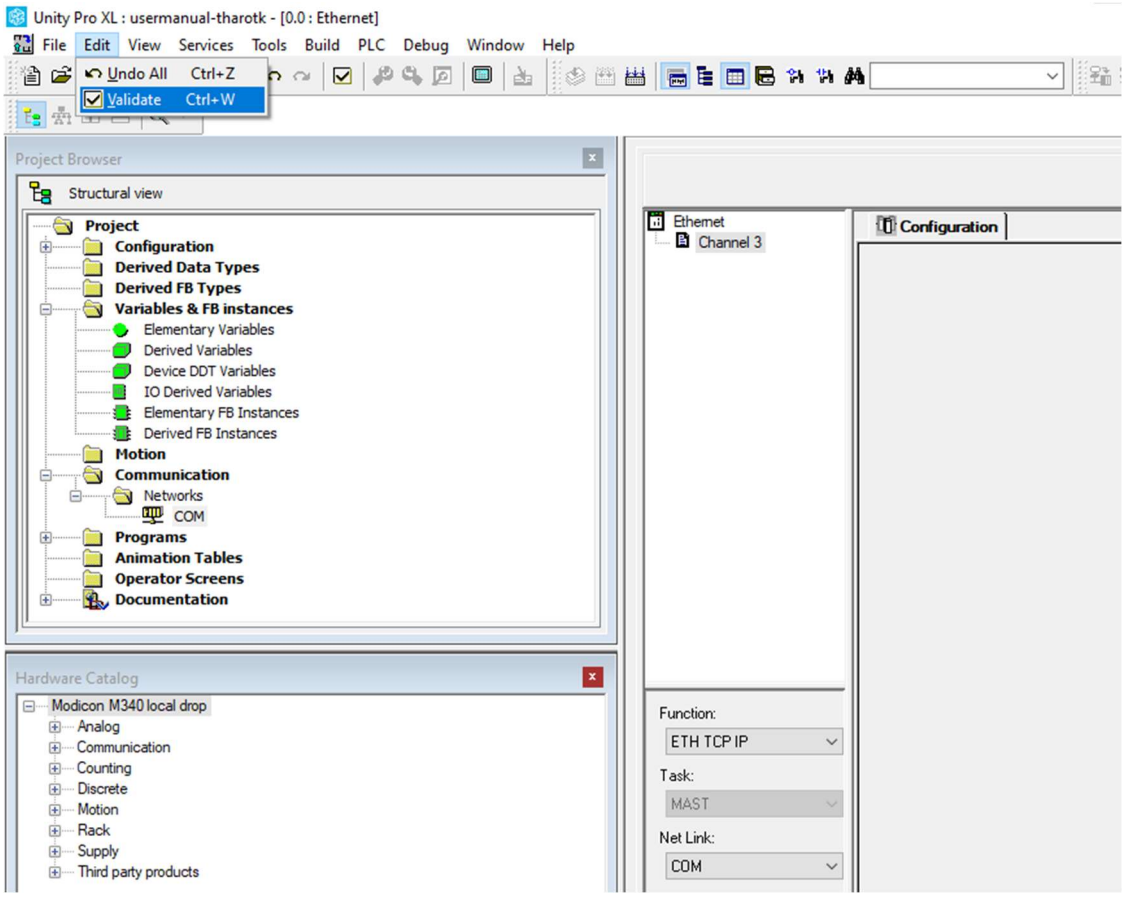



If you get this error as following:


Unity Pro XL : usermanual-tharotk - [0.0 : Ethernet]
File Edit View Services Tools Build PLC Debug Window Help
Project Browser
Structural view
Project
Configuration
Derived Data Types
Derived FB Types
Variables & FB instances
Elementary Variables
Derived Variables
Device DDT Variables
IO Derived Variables
Elementary FB Instances
Derived FB Instances
Motion
Communication
Networks
COM
Programs
Animation Tables
Operator Screens
Documentation
Hardware Catalog
Modicon M340 local drop
Analog
Communication
Counting
Discrete
Motion
Rack
Supply
Third party products
Ethernet
Channel 3
Configuration
Function:
ETH TCP IP
Task:
MAST
Net Link:
COM


Undo All Ctrl+Z
Validate Ctrl+W


Unity Pro XL : usermanual-tharotk - [0.0 : Ethernet]
File Edit View Services Tools Build PLC Debug Window Help
Undo All Ctrl+Z
Validate Ctrl+W
Project Browser
Structural view
Project
Configuration
Derived Data Types
Derived FB Types
Variables & FB instances
Elementary Variables
Derived Variables
Device DDT Variables
IO Derived Variables
Elementary FB Instances
Derived FB Instances
Motion
Communication
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Supply
Third party products
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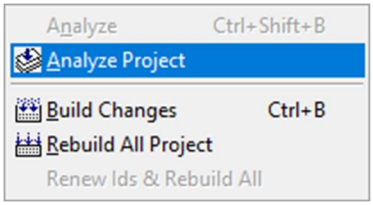
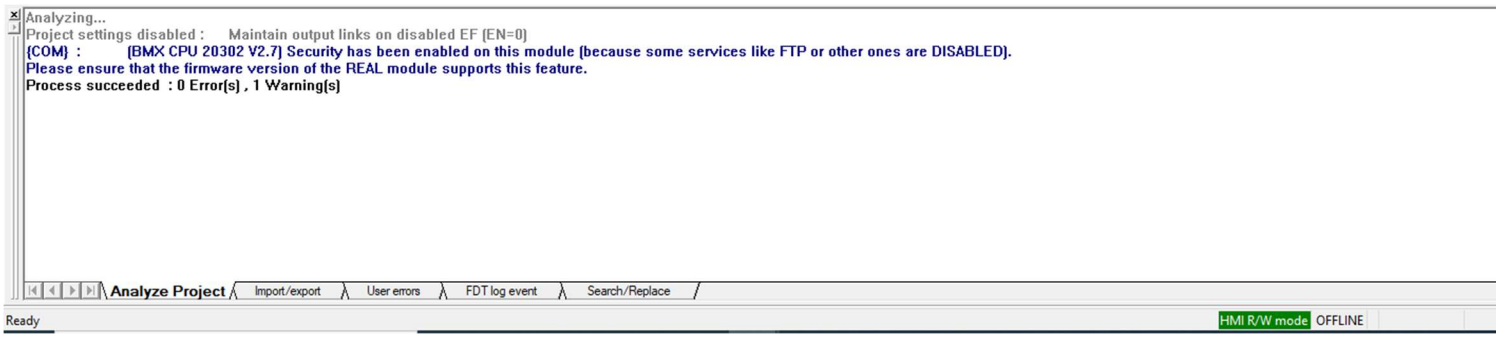
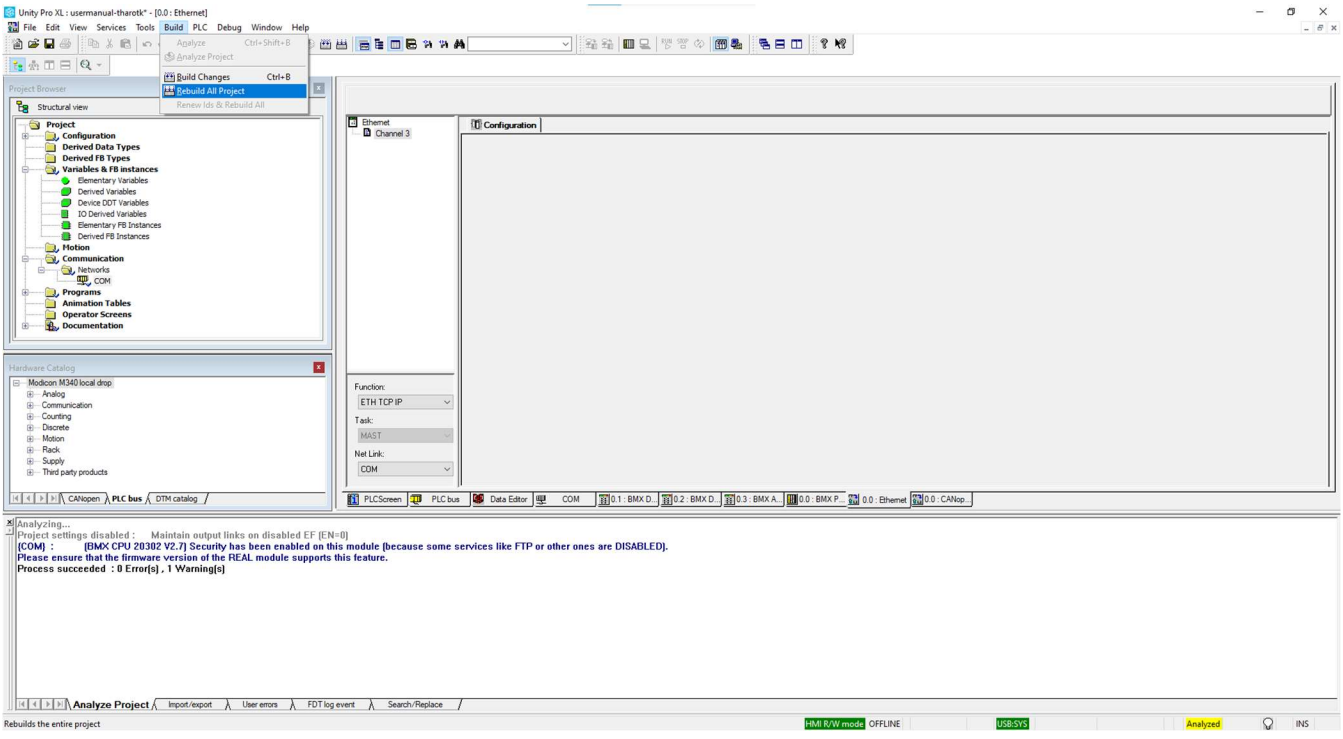
Channel 3
Configuration
Function:
ETH TCP IP
Task:
MAST
Net Link:
COM


Analyze Ctrl+Shift+B
Analyze Project
Build Changes Ctrl+B
Rebuild All Project
Renew Ids & Rebuild All


Analyzing...
Project settings disabled : Maintain output links on disabled EF (EN=0)
{COM} : (BMX CPU 20302 V2.7] Security has been enabled on this module (because some services like FTP or other ones are DISABLED).
Please ensure that the firmware version of the REAL module supports this feature.
Process succeeded : 0 Error(s) , 1 Warning(s)
Analyze Project
Import/export
User errors
FDT log event
Search/Replace
Ready
HMI R/W mode
OFFLINE


Unity Pro XL : usermanual-tharotk* - [0.0 : Ethernet]
File Edit View Services Tools Build PLC Debug Window Help
Analyze Ctrl+Shift+B
Analyze Project
Build Changes Ctrl+B
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Hardware Catalog
Modicon M340 local drop
Analog
Communication
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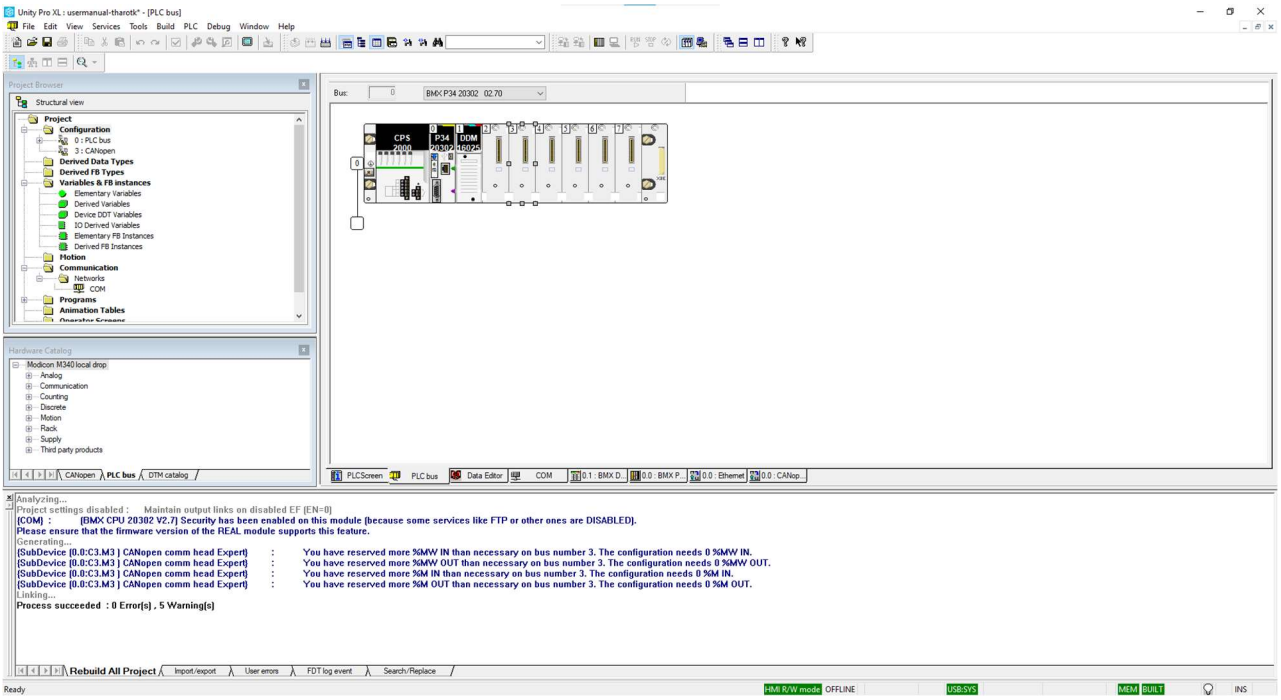
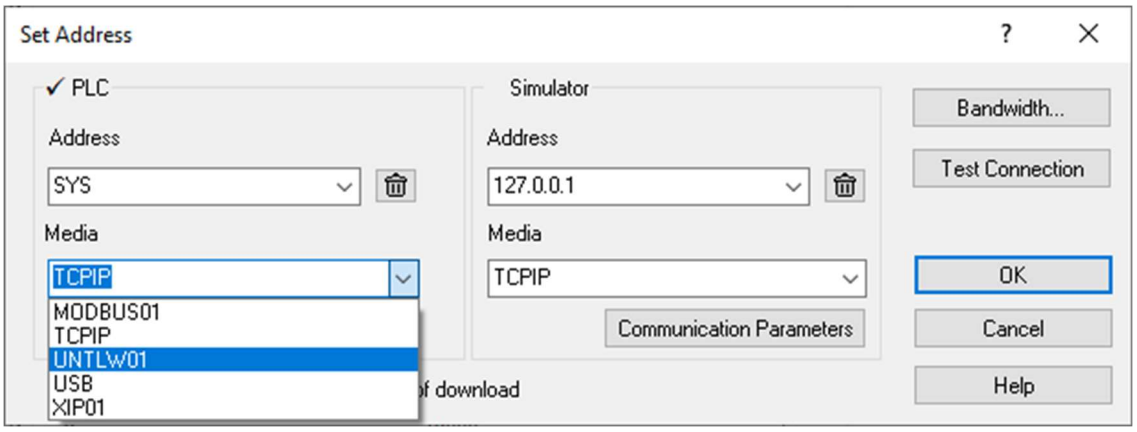
Third party products
CANopen
PLC bus
DTM catalog
Ethernet
Channel 3
Configuration
Function:
ETH TCP IP
Task:
MAST
Net Link:
COM
PLCScreen
PLC bus
Data Editor
COM
0.1 : BMX D...
0.2 : BMX D...
0.3 : BMX A...
0.0 : BMX P...
0.0 : Ethernet
0.0 : CANop...
Analyzing...
Project settings disabled : Maintain output links on disabled EF (EN=0)
{COM} : (BMX CPU 20302 V2.7] Security has been enabled on this module (because some services like FTP or other ones are DISABLED).
Please ensure that the firmware version of the REAL module supports this feature.
Process succeeded : 0 Error(s) , 1 Warning(s)
Analyze Project
Import/export
User errors
FDT log event
Search/Replace
Rebuilds the entire project
HMI R/W mode
OFFLINE
USB:SYS
Analyzed
INS


Unity Pro XL : usermanual-tharotk* - [PLC bus]
File Edit View Services Tools Build PLC Debug Window Help
Project Browser
Structural view
Project
Configuration
0 : PLC bus
3 : CANopen
Derived Data Types
Derived FB Types
Variables & FB instances
Elementary Variables
Derived Variables
Device DDT Variables
IO Derived Variables
Elementary FB Instances
Derived FB Instances
Motion
Communication
Networks
COM
Programs
Animation Tables
Hardware Catalog
Modicon M340 local drop
Analog
Communication
Counting
Discrete
Motion
Rack
Supply
Third party products
CANopen
PLC bus
DTM catalog
Bus:
BMX P34 20302 02.70
CPS 2000
P34 20302
DDM 16D24
PLCScreen
PLC bus
Data Editor
COM
0.1 : BMX D...
0.0 : BMX P...
0.0 : Ethernet
0.0 : CANop...
Analyzing...
Project settings disabled : Maintain output links on disabled EF (EN=0)
(COM) : [BMX CPU 20302 V2.7] Security has been enabled on this module (because some services like FTP or other ones are DISABLED).
Please ensure that the firmware version of the REAL module supports this feature.
Generating...
(SubDevice (0.0:C3.M3 ) CANopen comm head Expert) : You have reserved more %MW IN than necessary on bus number 3. The configuration needs 0 %MW IN.
(SubDevice (0.0:C3.M3 ) CANopen comm head Expert) : You have reserved more %MW OUT than necessary on bus number 3. The configuration needs 0 %MW OUT.
(SubDevice (0.0:C3.M3 ) CANopen comm head Expert) : You have reserved more %M IN than necessary on bus number 3. The configuration needs 0 %M IN.
(SubDevice (0.0:C3.M3 ) CANopen comm head Expert) : You have reserved more %M OUT than necessary on bus number 3. The configuration needs 0 %M OUT.
Linking...
Process succeeded : 0 Error(s) , 5 Warning(s)
Rebuild All Project
Import/export
User errors
FDT log event
Search/Replace
Ready
HMI R/W mode OFFLINE
USB:SYS
MEM BUILT
INS


Ready
HMI R/W mode OFFLINE
USB:SYS
MEM BUILT
INS
Ready
HMI R/W mode OFFLINE
TCPIP:127.0.0.1
NOT BUILT
INS
Ready
HMI R/W mode OFFLINE
TCPIP:127.0.0.1
MEM BUILT
INS
Ready
HMI R/W mode OFFLINE
USB:SYS
NOT BUILT
INS
Ready
HMI R/W mode OFFLINE
USB:SYS
MEM BUILT
INS

# Download program to PLC

Send program to the screen



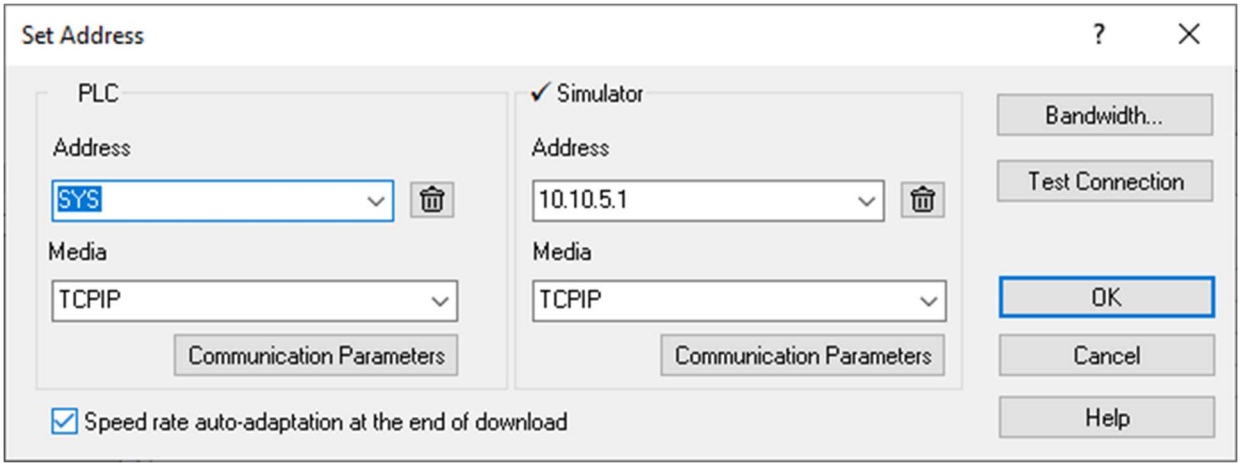

# Run program

You can see the interface is running

It confirmed that we are running on the PLC

We also can run on the simulation

You can see the differences of running on **PLC** and **simulation**




Example here for the simulation

# Hands on the control problem

**The control problem**

For practical (available space) reasons, it is not possible to have 12 plants to be controlled by the 12 PLCs. Therefore the plant is simulated by a “simulation card” which is actually an embedded system built around a microprocessor and allowing programming for simulation of plants...

However the PLC receives “true signals” on the I/O card interacting with the “simulation card”. Figure 2 displays the lab configuration (it is called a Hardware in the Loop simulation).

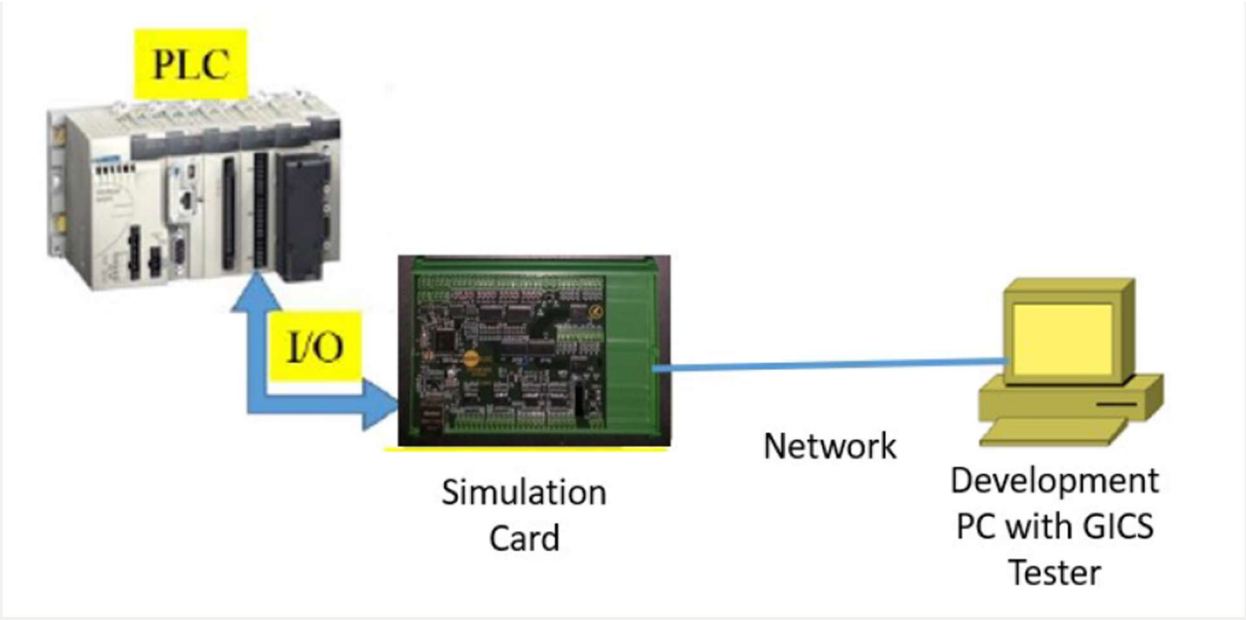


Figure 2. Hardware in the loop bench

The (very simple) control problem that you have to solve is the following:

Consider a fluid tank (Figure 3) equipped with two level digital sensors (minimal and maximal levels) and two actuators (the two valves).

There is also an external signal ("client request" for fluid supply). Your program has then three digital inputs and two digital outputs.

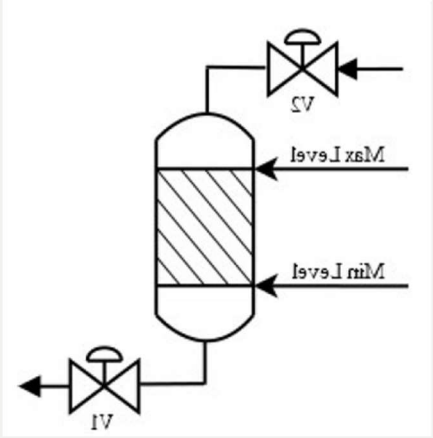


Figure 3 A simple tank

## Control specification

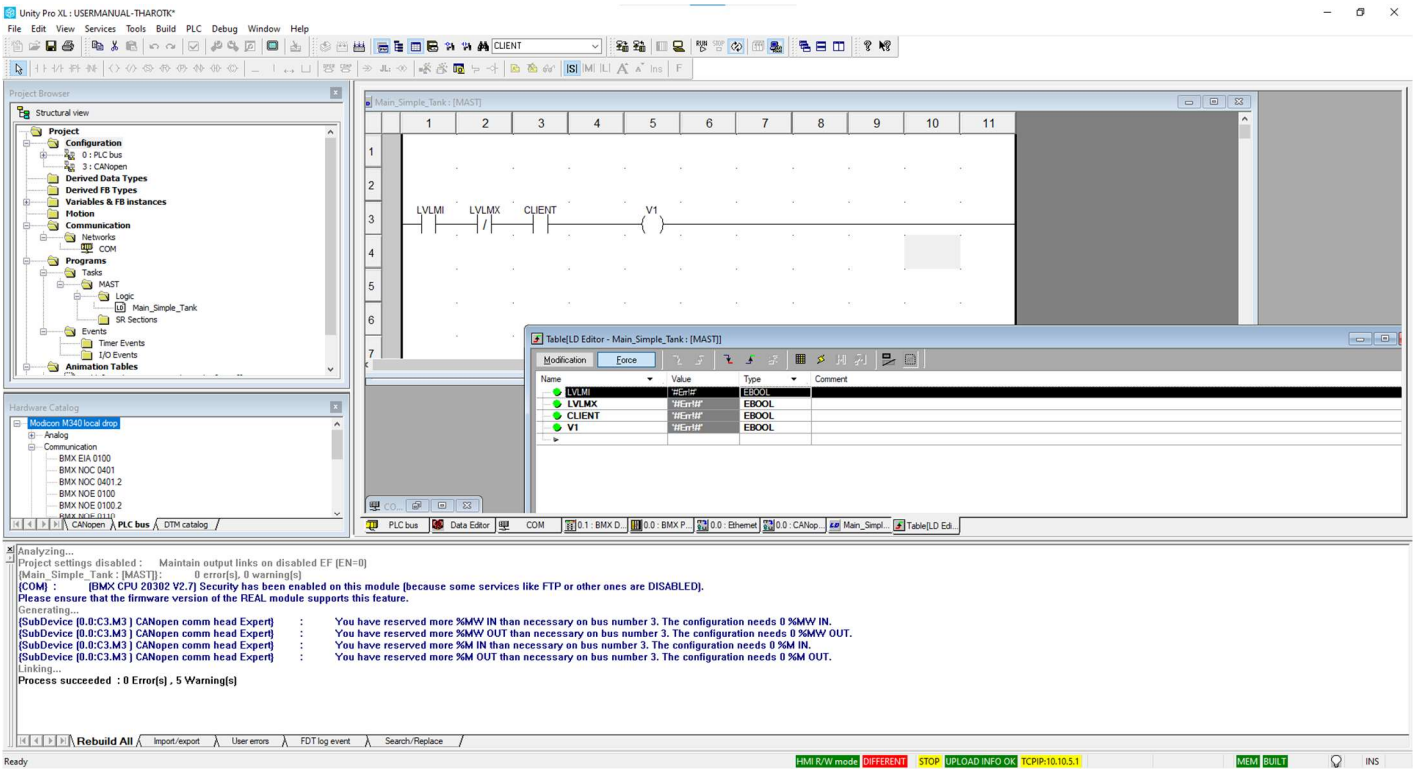
Your main objective is to keep the fluid level between the min and max levels. You'll also serve the client requests for the fluid supply. The control logic specification is:

If the tank level is between min and max and a client request is raised open the valve V1 as long as the client request is active.

If the tank level reaches level min (that will necessary happen when V1 is open) close V1 and open V2 until the tank level reaches level max. When the tank level reaches max close V2

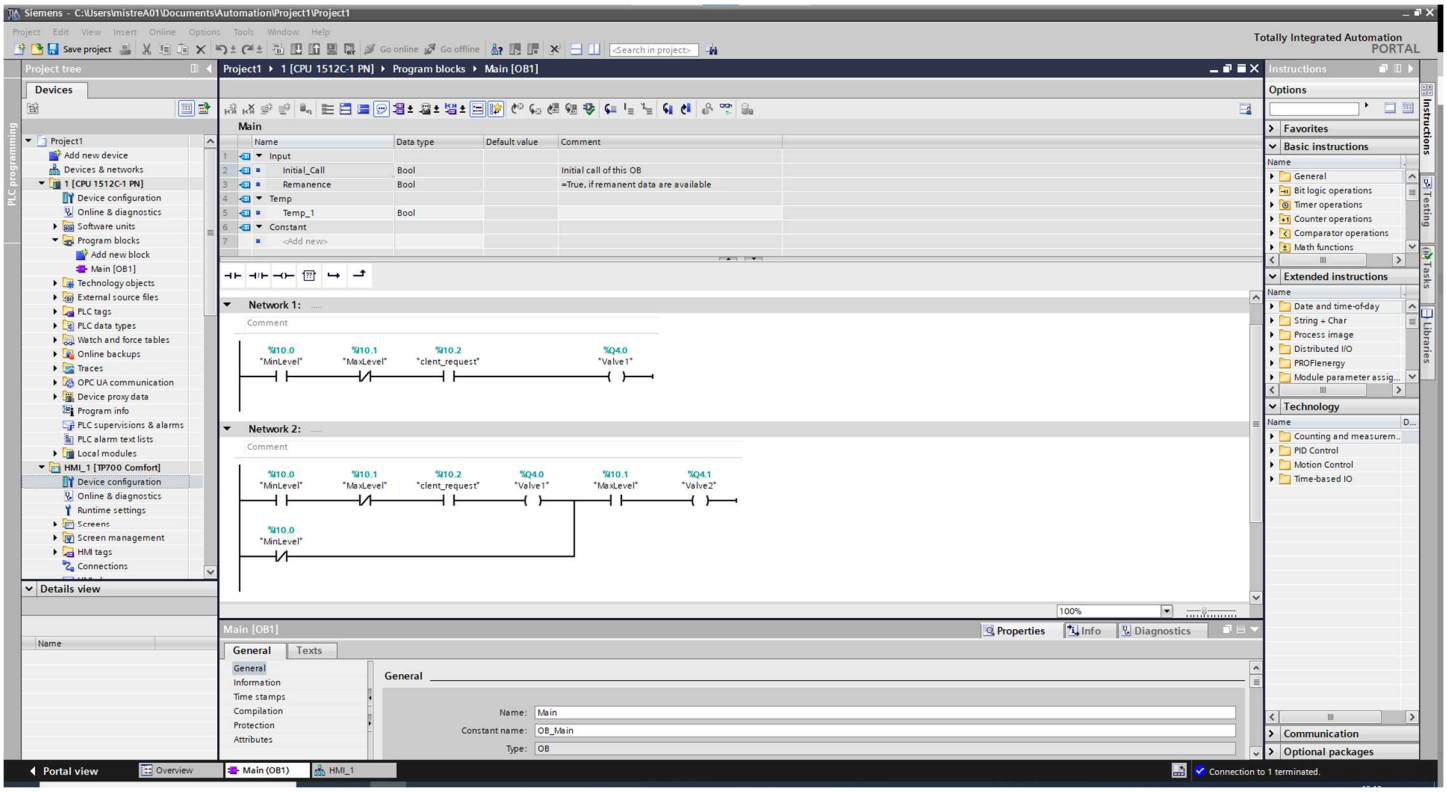
OPTIONAL:

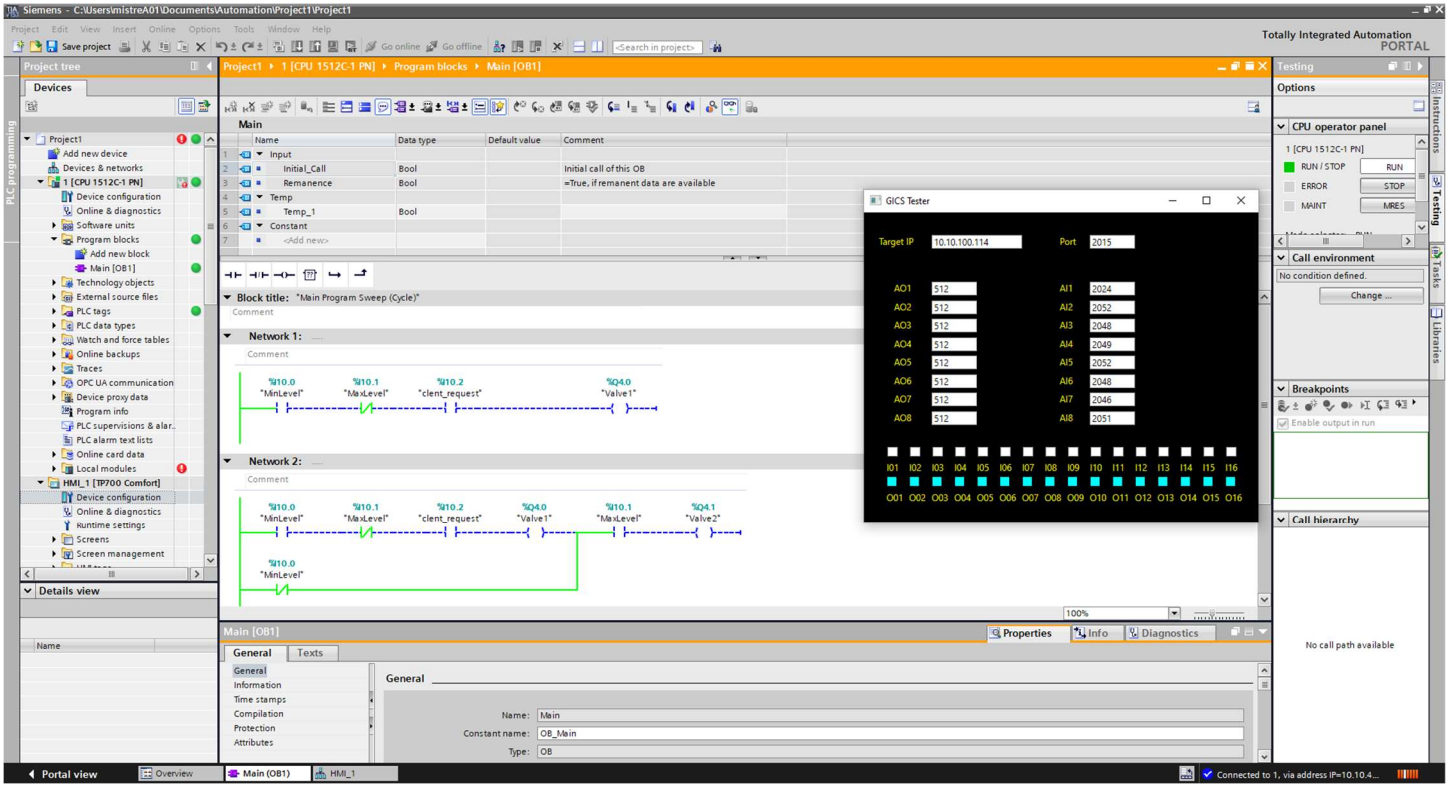
Supplementary diagnostic tasks: if level min and max are simultaneously activated (sensors failure) or level min is active raise an error (set an error bit in the PLC memory) write the error code (0x01) in a memory word and wait for an external error acknowledgement before going back to the normal state.

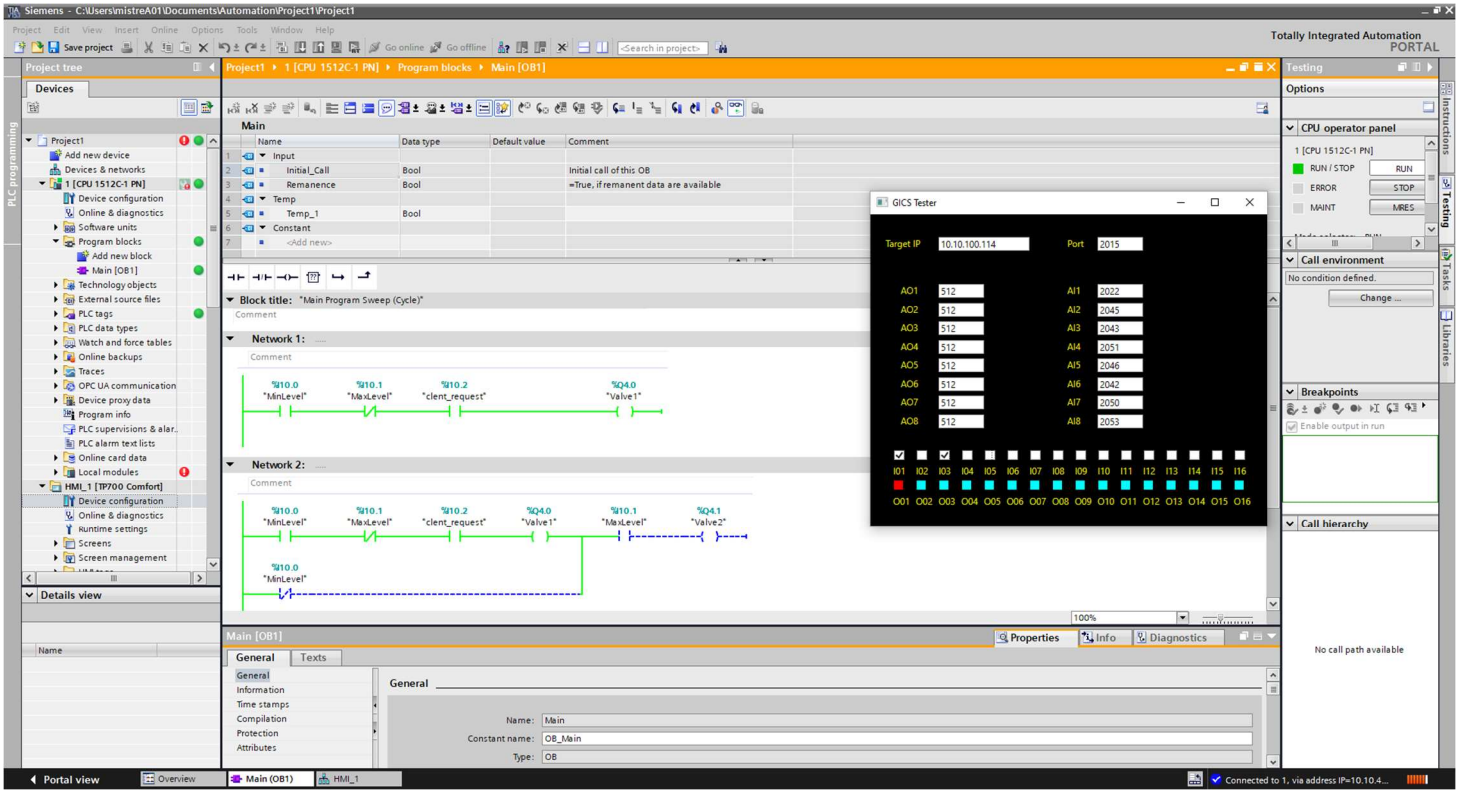


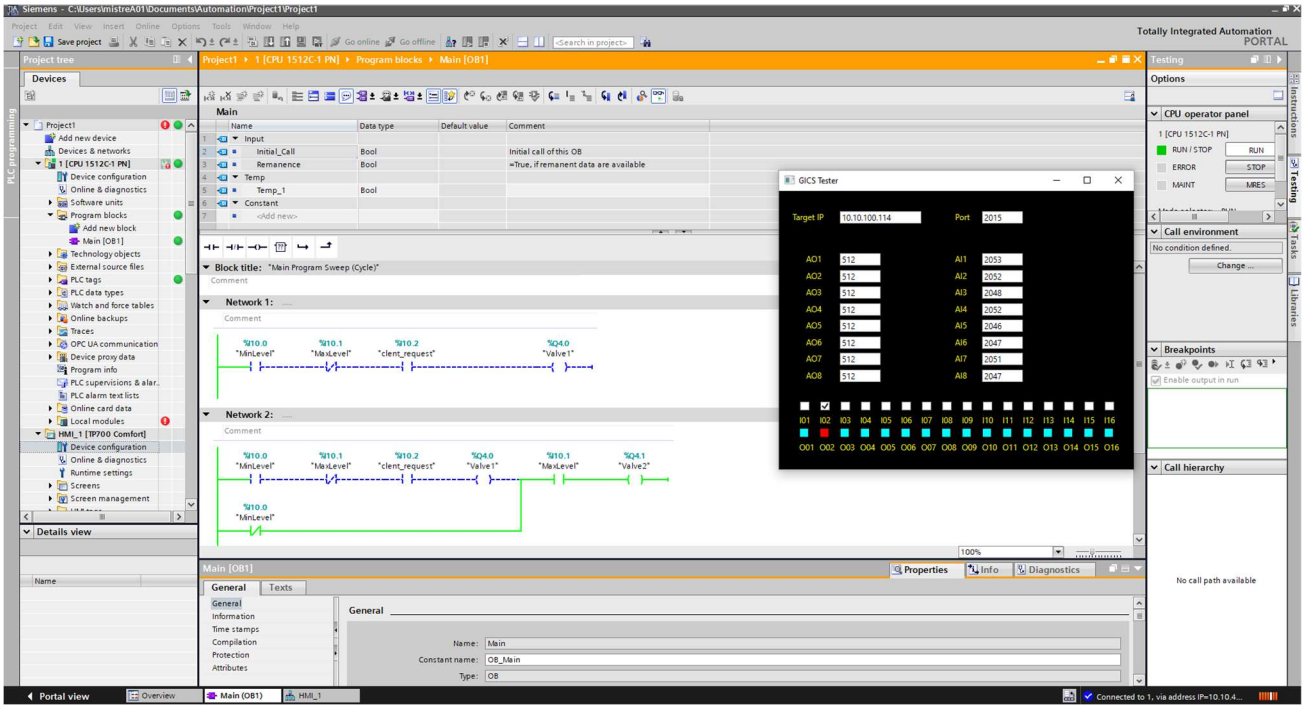

# PLC result on the control problem

You can check your I/O with GICS Tester



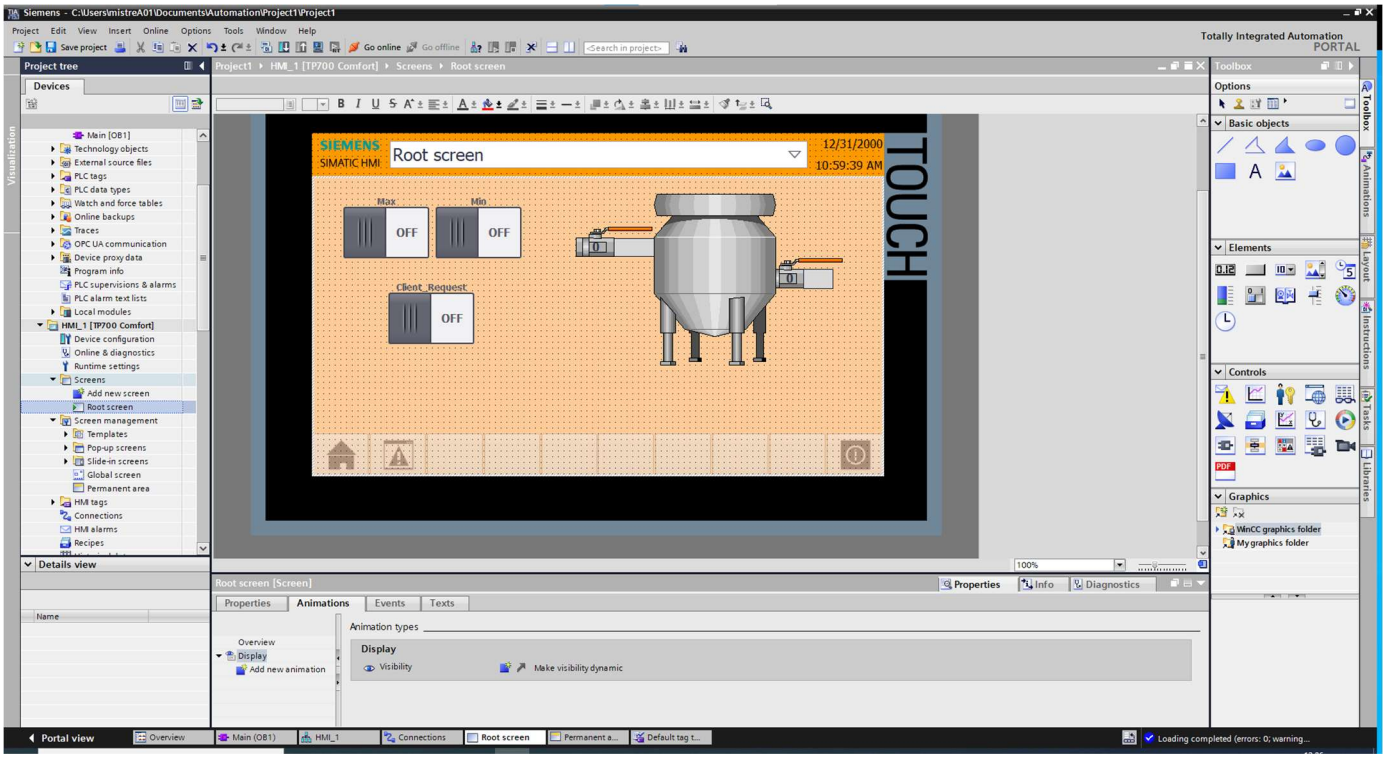

Siemens - C:\Users\mistreA01\Documents\Automation\Project1\Project1
Totally Integrated Automation PORTAL
Project tree
Devices
Project1 ▸ 1 [CPU 1512C-1 PN] ▸ Program blocks ▸ Main [OB1]
Main
Name
Data type
Default value
Comment
Input
Initial_Call
Bool
Initial call of this OB
Remanence
Bool
=True, if remanent data are available
Temp
Temp_1
Bool
Constant
<Add new>
Block title: "Main Program Sweep (Cycle)"
Comment
Network 1:
Comment
%I0.0 "MinLevel"
%I0.1 "MaxLevel"
%I0.2 "clent_request"
%Q4.0 "Valve1"
Network 2:
Comment
%I0.0 "MinLevel"
%I0.1 "MaxLevel"
%I0.2 "clent_request"
%Q4.0 "Valve1"
%I0.1 "MaxLevel"
%Q4.1 "Valve2"
%I0.0 "MinLevel"
GICS Tester
Target IP
10.10.100.114
Port
2015
AO1 512
AO2 512
AO3 512
AO4 512
AO5 512
AO6 512
AO7 512
AO8 512
AI1 2024
AI2 2052
AI3 2048
AI4 2049
AI5 2052
AI6 2048
AI7 2046
AI8 2051
I01 I02 I03 I04 I05 I06 I07 I08 I09 I10 I11 I12 I13 I14 I15 I16
O01 O02 O03 O04 O05 O06 O07 O08 O09 O10 O11 O12 O13 O14 O15 O16
Testing
Options
CPU operator panel
1 [CPU 1512C-1 PN]
RUN / STOP
RUN
ERROR
STOP
MAINT
MRES
Call environment
No condition defined.
Change ...
Breakpoints
Enable output in run
Call hierarchy
No call path available
Details view
Main [OB1]
Properties
Info
Diagnostics
General
Texts
General
Information
Time stamps
Compilation
Protection
Attributes
Name: Main
Constant name: OB_Main
Type: OB
Portal view
Overview
Main (OB1)
HMI_1
Connected to 1, via address IP=10.10.4...

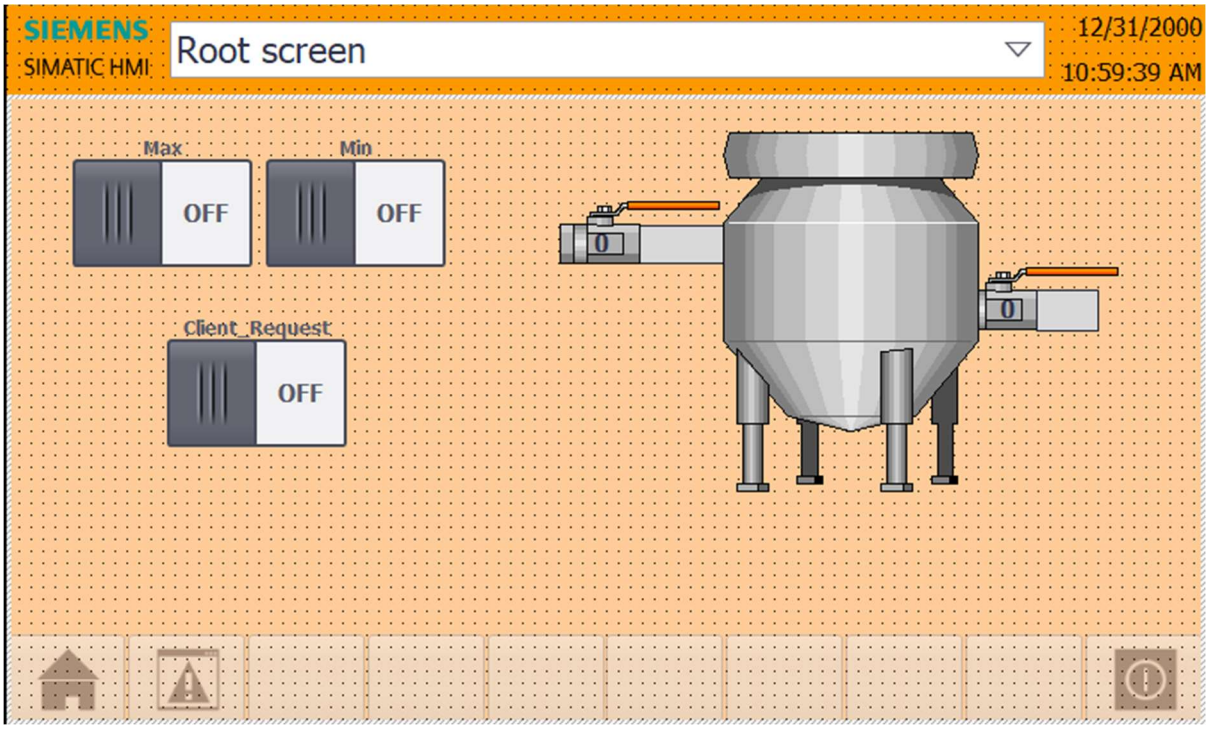

Siemens - C:\Users\mistreA01\Documents\Automation\Project1\Project1
Totally Integrated Automation PORTAL
Project tree
Devices
Project1 ▸ 1 [CPU 1512C-1 PN] ▸ Program blocks ▸ Main [OB1]
Main
Name
Data type
Default value
Comment
Input
Initial_Call
Bool
Initial call of this OB
Remanence
Bool
=True, if remanent data are available
Temp
Temp_1
Bool
Constant
<Add new>
Block title: "Main Program Sweep (Cycle)"
Comment
Network 1:
Comment
%I0.0 "MinLevel"
%I0.1 "MaxLevel"
%I0.2 "clent_request"
%Q4.0 "Valve1"
Network 2:
Comment
%I0.0 "MinLevel"
%I0.1 "MaxLevel"
%I0.2 "clent_request"
%Q4.0 "Valve1"
%I0.1 "MaxLevel"
%Q4.1 "Valve2"
%I0.0 "MinLevel"
GICS Tester
Target IP
10.10.100.114
Port
2015
AO1 512
AO2 512
AO3 512
AO4 512
AO5 512
AO6 512
AO7 512
AO8 512
AI1 2022
AI2 2045
AI3 2043
AI4 2051
AI5 2046
AI6 2042
AI7 2050
AI8 2053
I01 I02 I03 I04 I05 I06 I07 I08 I09 I10 I11 I12 I13 I14 I15 I16
O01 O02 O03 O04 O05 O06 O07 O08 O09 O10 O11 O12 O13 O14 O15 O16
Testing
Options
CPU operator panel
1 [CPU 1512C-1 PN]
RUN / STOP
RUN
ERROR
STOP
MAINT
MRES
Call environment
No condition defined.
Change ...
Breakpoints
Enable output in run
Call hierarchy
No call path available
Details view
Main [OB1]
Properties
Info
Diagnostics
General
Texts
General
Information
Time stamps
Compilation
Protection
Attributes
Name: Main
Constant name: OB_Main
Type: OB
Portal view
Overview
Main (OB1)
HMI_1
Connected to 1, via address IP=10.10.4...

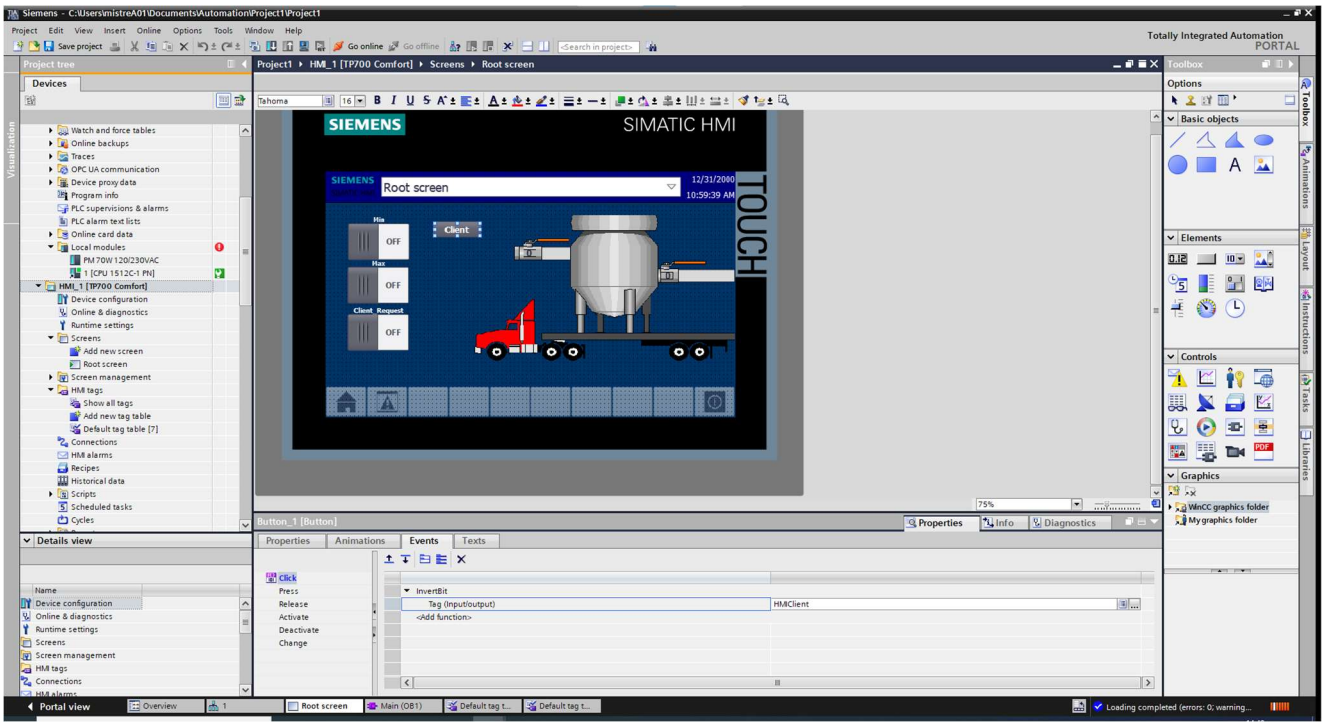


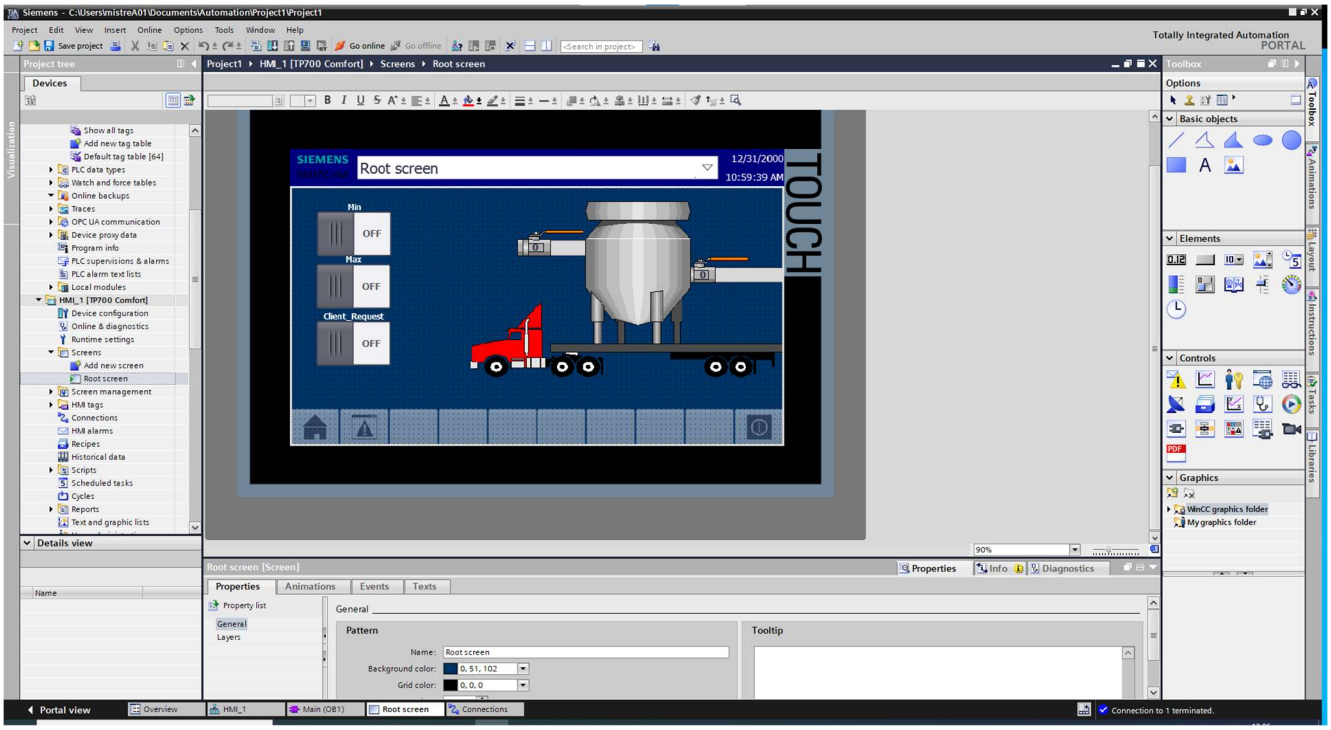

# HMI result on the control problem

You can check your I/O with GICS Tester




SIEMENS
SIMATIC HMI
Root screen
12/31/2000
10:59:39 AM
Max
OFF
Min
OFF
Client_Request
OFF


Siemens - C:\Users\mistreA01\Documents\Automation\Project1\Project1
Totally Integrated Automation
PORTAL
Project tree
Devices
Project1 ▸ HMI_1 [TP700 Comfort] ▸ Screens ▸ Root screen
Toolbox
SIEMENS
SIMATIC HMI
Root screen
12/31/2000
10:59:39 AM
TOUCH
Client
Details view
Properties
Animations
Events
Texts
Click
Press
Release
Activate
Deactivate
Change
InvertBit
Tag (Input/output)
HMIClient
<Add function>
Portal view
Overview
Root screen
Loading completed (errors: 0; warning...

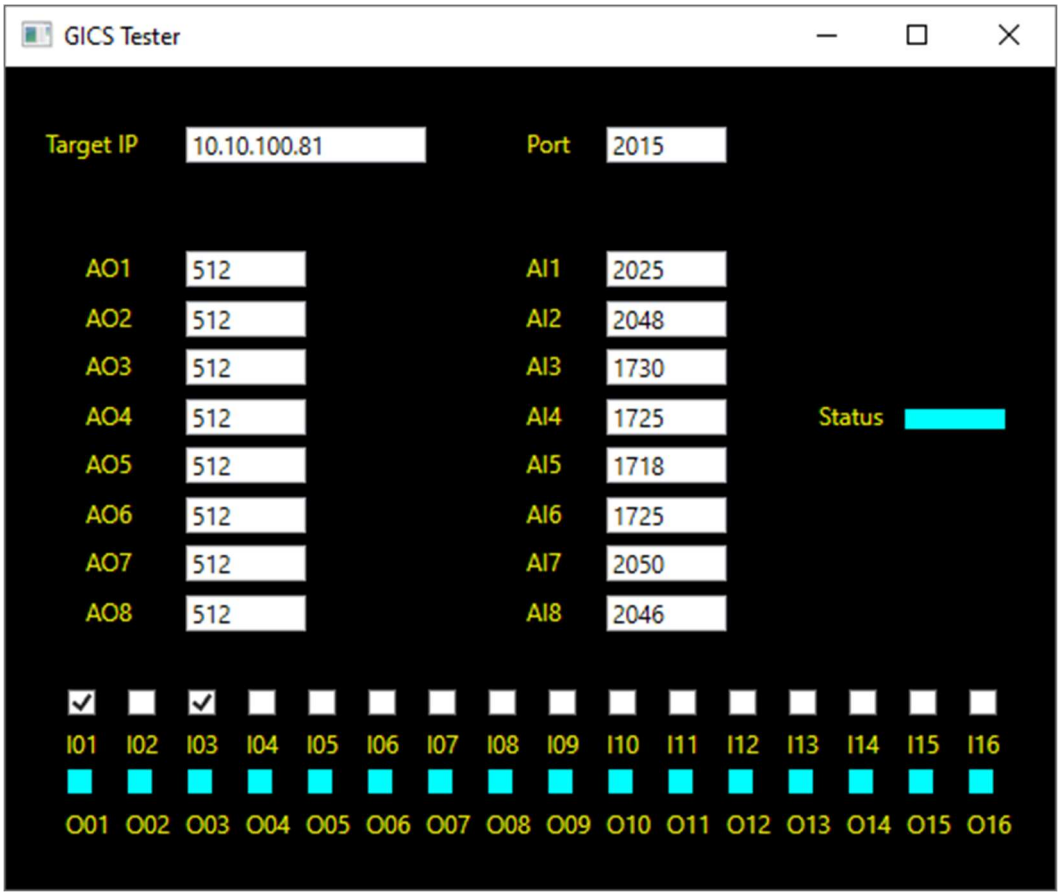



# Tools

## GICS Tester

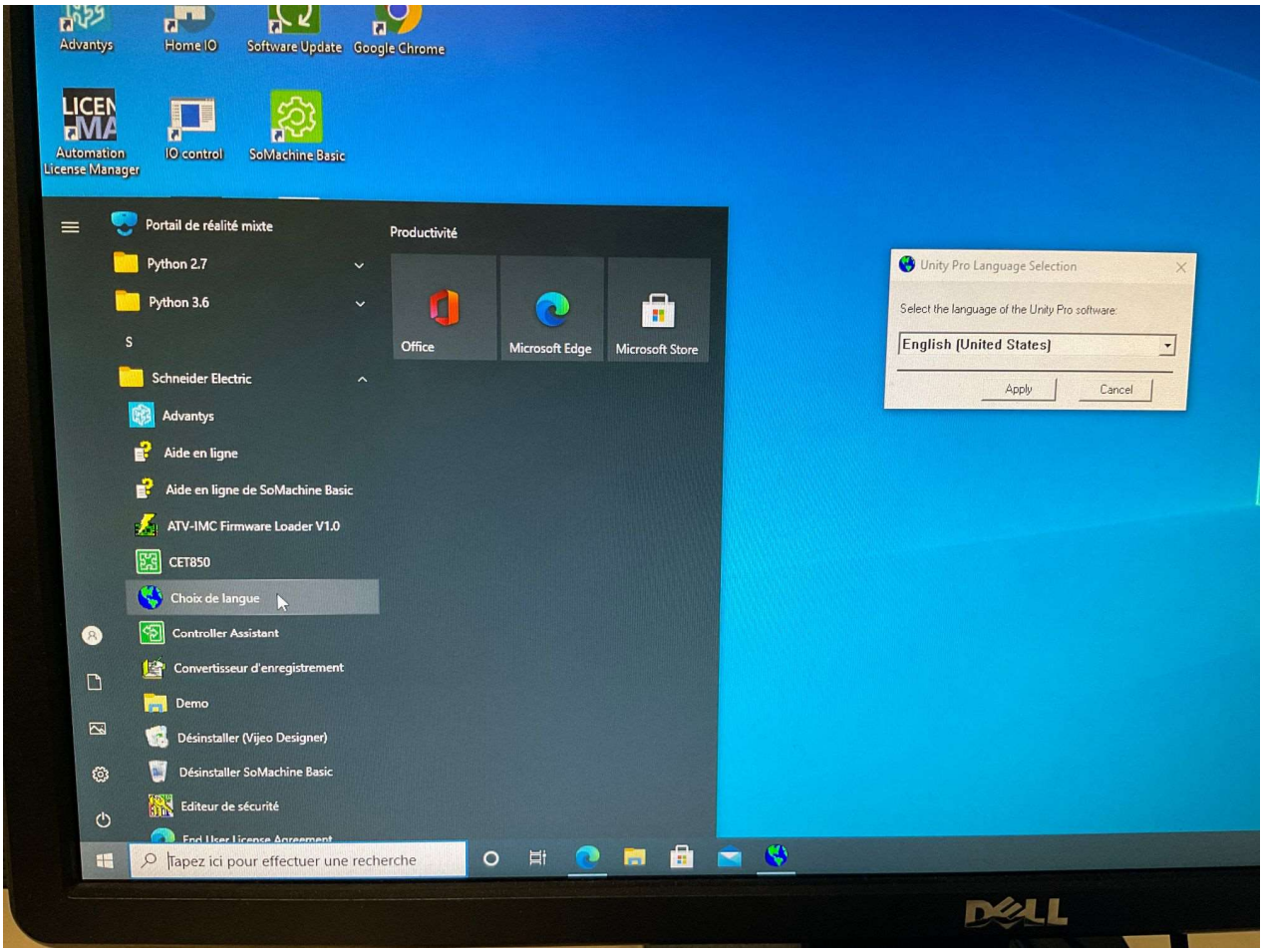
"**GICS-Tester** is an interface allowing to interact remotely with an Emulation-card. The Emulation card (IP 10.10.100.113 for instance) is a card allowing to emulate a physical process, and the inputs-outputs (both analog and digital) are physically connected to a PLC (ex 10.10.4.21). So the PLC receives physical signals coming from the Emulation cards, uses these signals for the PLC programme, then sent physically its outputs back to the Emulation cards. When using GICS tester, we just control manually the inputs, which are sent from the computer (ex: 10.10.3.4) to the emulation cards through the network (port 2015 is used).

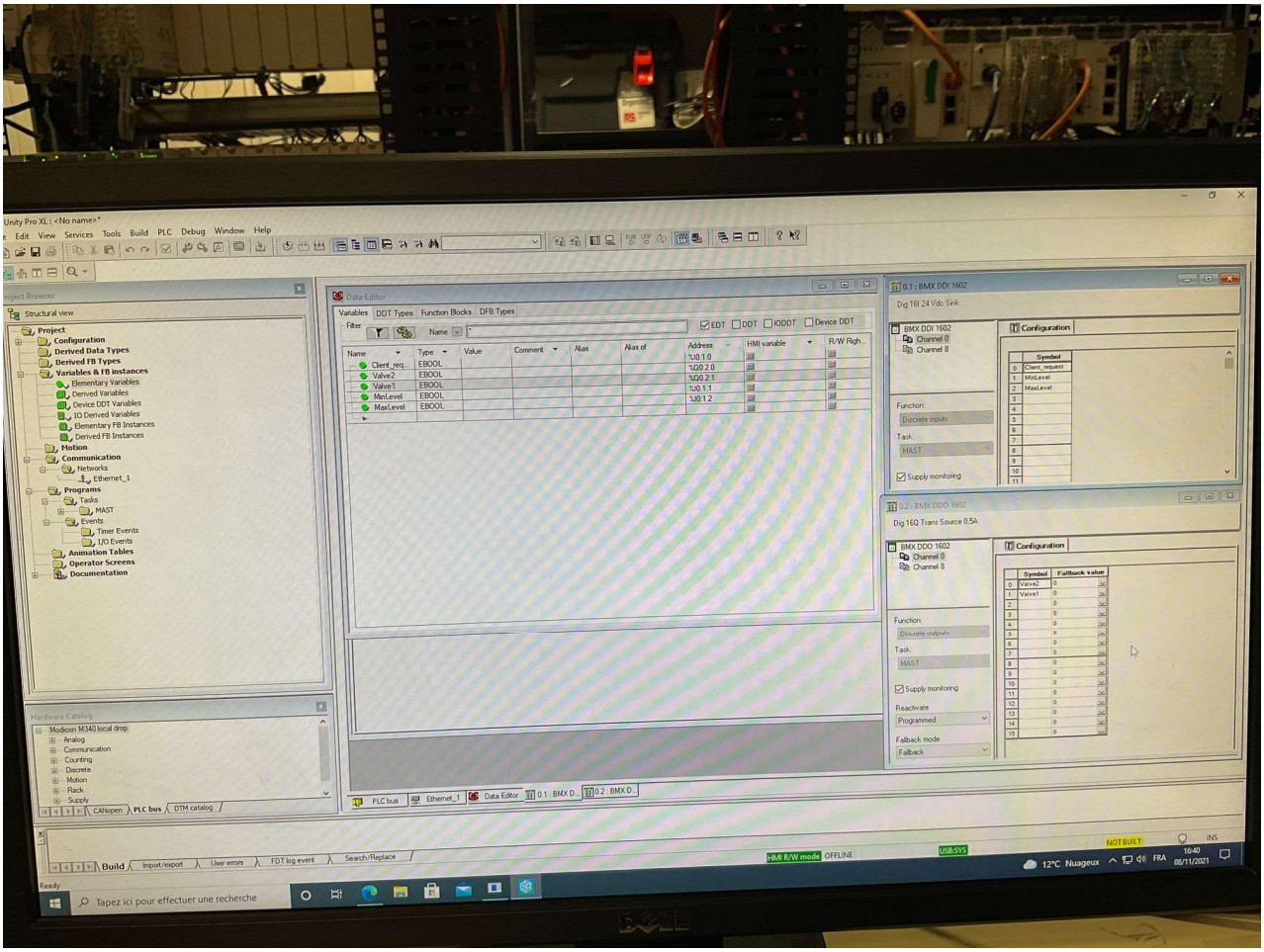
For other applications, it is possible to embed a programme on the Emulation card and use another programme for the interface with it."

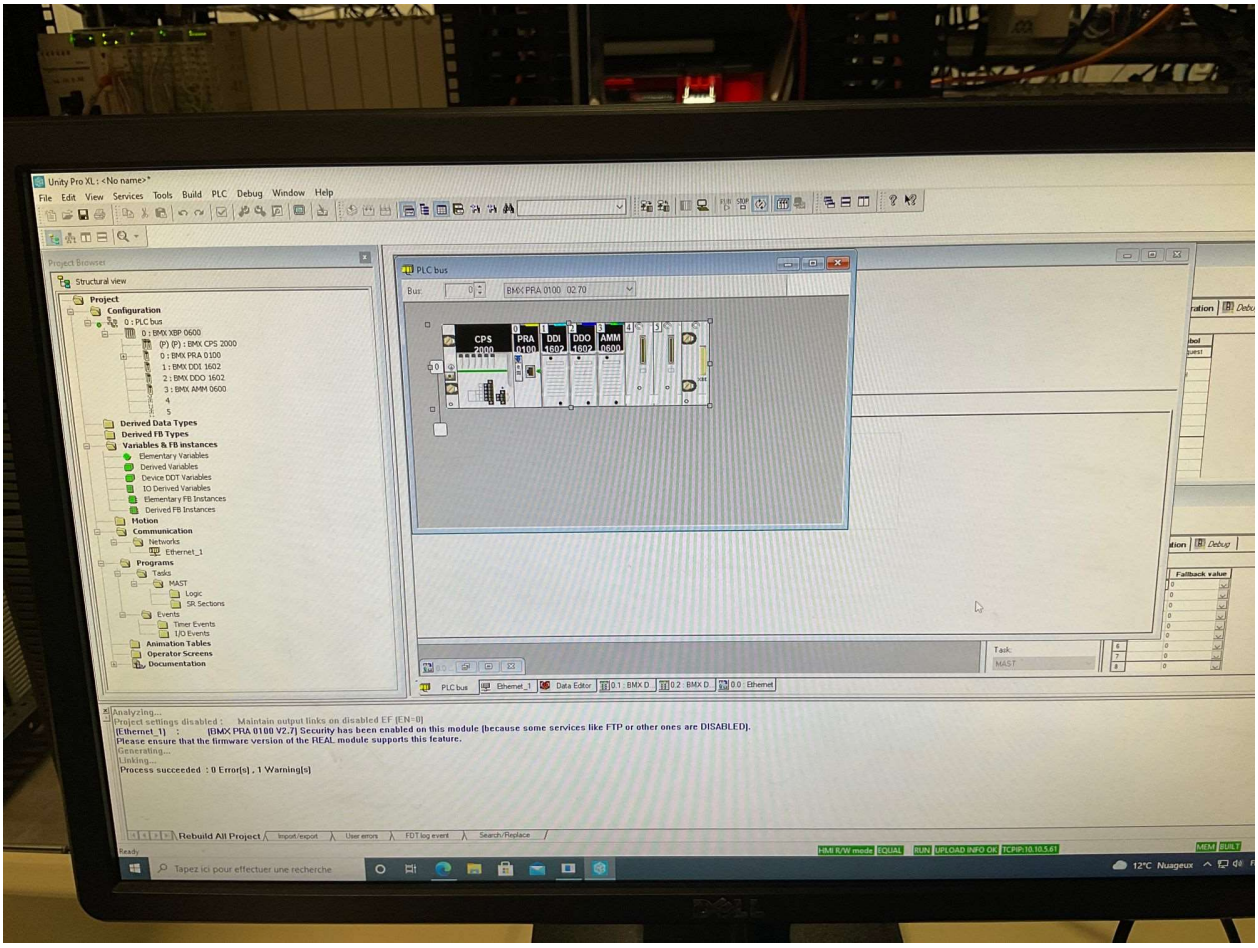


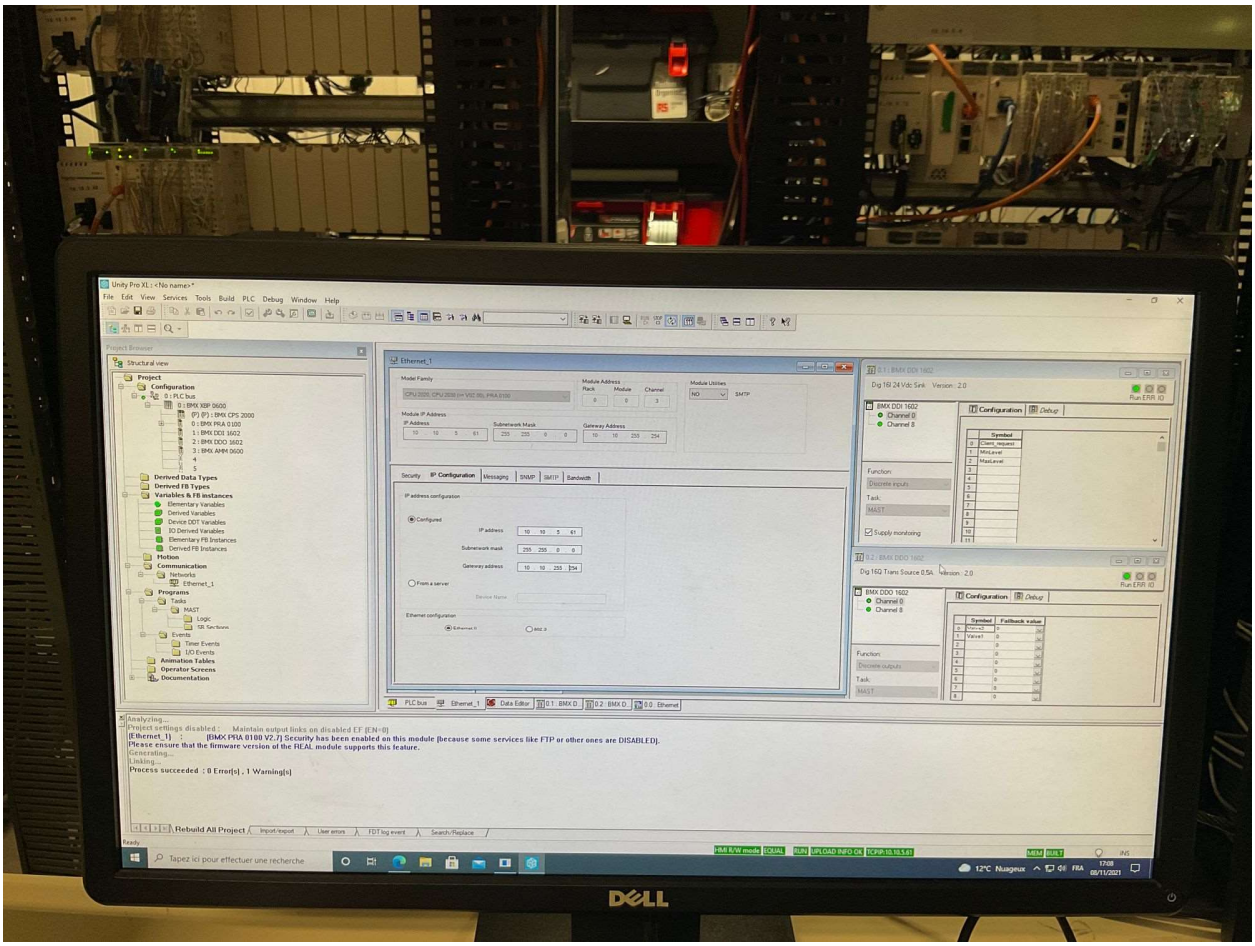

"H:\00_new_hil\GICS Tester.exe

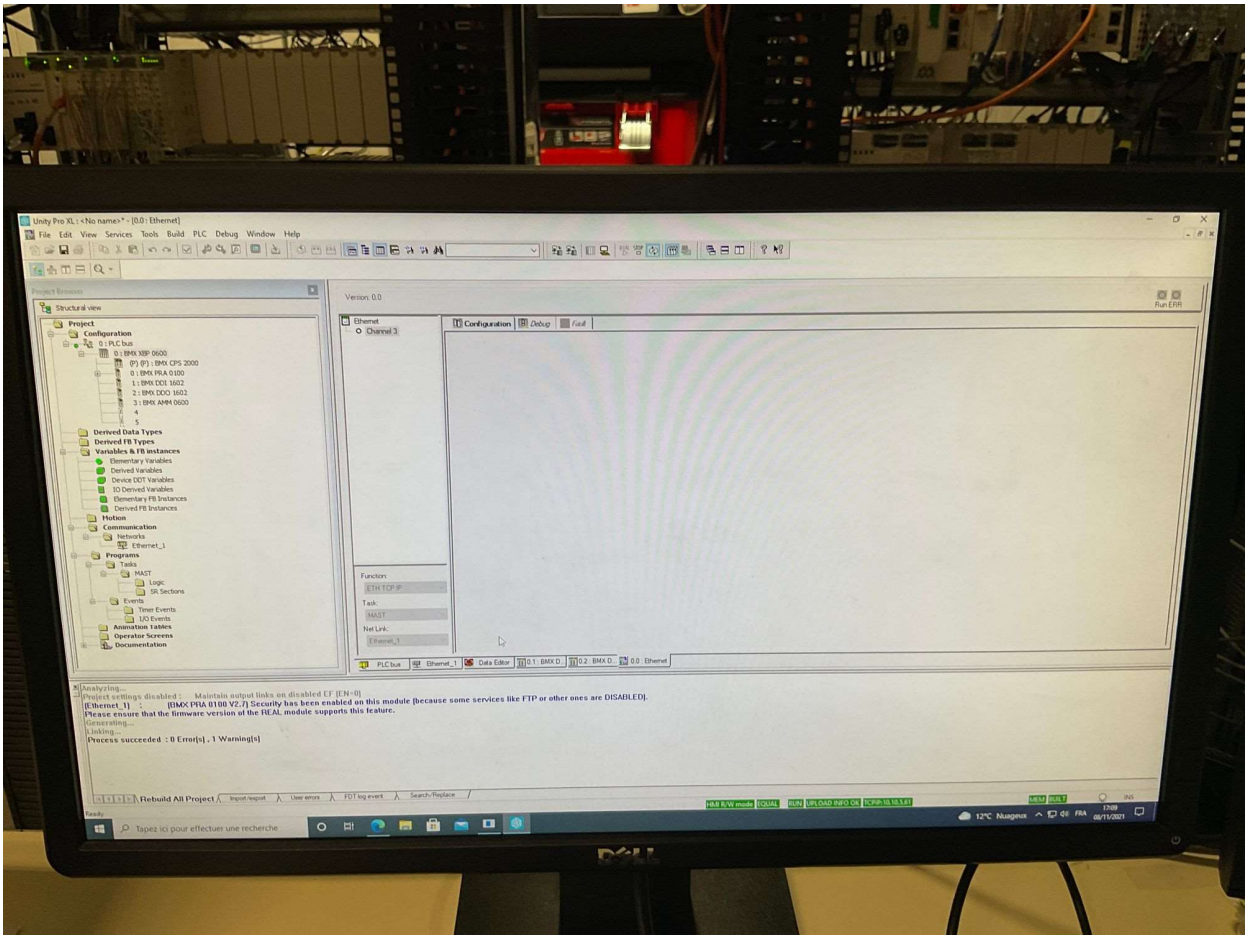
# Appendix

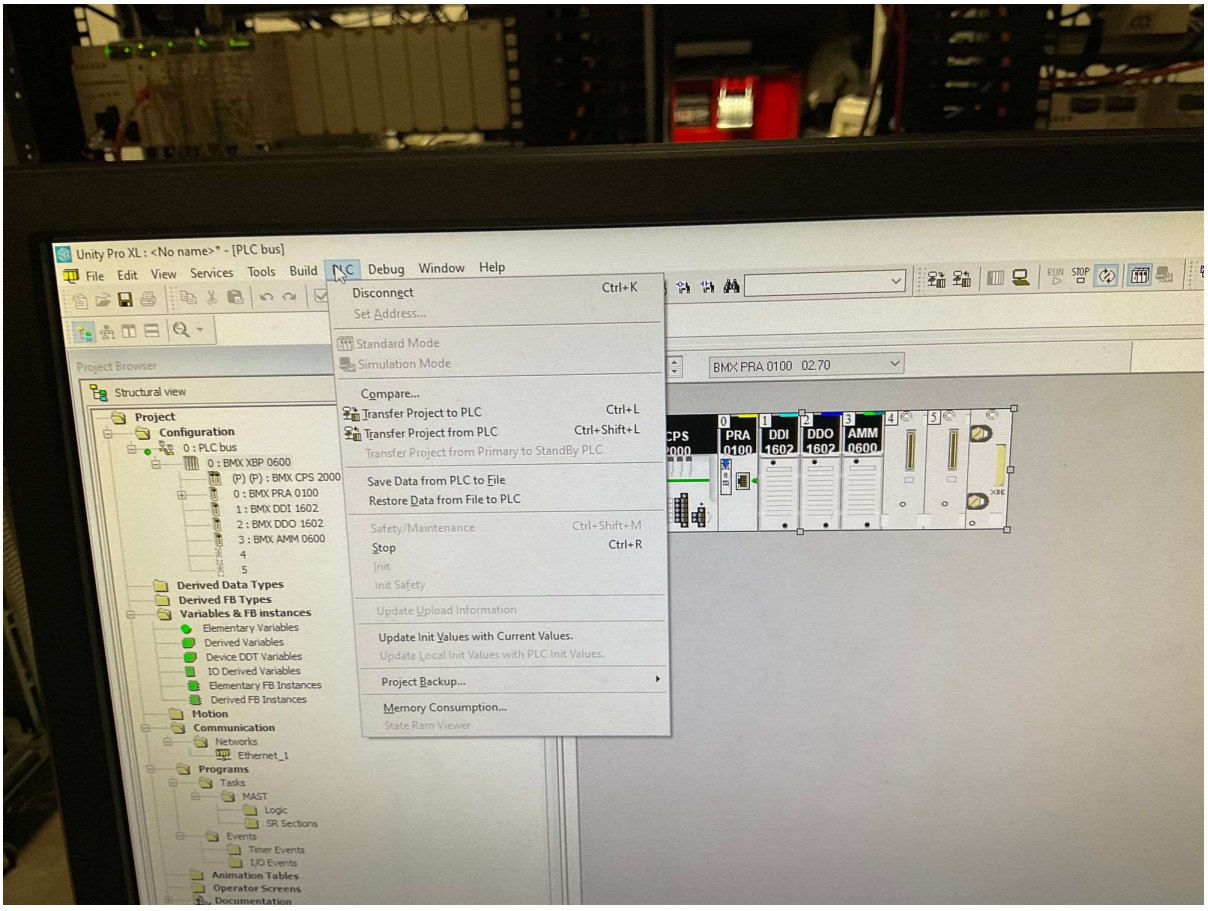

Advantys
Home IO
Software Update
Google Chrome
Automation License Manager
IO control
SoMachine Basic
Portail de réalité mixte
Python 2.7
Python 3.6
S
Schneider Electric
Advantys
Aide en ligne
Aide en ligne de SoMachine Basic
ATV-IMC Firmware Loader V1.0
CET850
Choix de langue
Controller Assistant
Convertisseur d'enregistrement
Demo
Désinstaller (Vijeo Designer)
Désinstaller SoMachine Basic
Editeur de sécurité
Productivité
Office
Microsoft Edge
Microsoft Store
Unity Pro Language Selection
Select the language of the Unity Pro software:
English (United States)
Apply
Cancel
Tapez ici pour effectuer une recherche
DELL


Unity Pro XL : <No name>*
Edit View Services Tools Build PLC Debug Window Help
Structural view
Project
Configuration
Derived Data Types
Derived FB Types
Variables & FB instances
Programs
Communication
Motion
Animation Tables
Operator Screens
Documentation
Data Editor
Variables
DDT Types
Function Blocks
DFB Types
Client_req
Valve2
Valve1
MinLevel
MaxLevel
Hardware Catalog
Build
Tapez ici pour effectuer une recherche
DELL


Unity Pro XL : <No name>*
File Edit View Services Tools Build PLC Debug Window Help
Project Browser
Structural view
Project
Configuration
0 : PLC bus
0 : BMX XBP 0600
(P) : BMX CPS 2000
0 : BMX PRA 0100
1 : BMX DDI 1602
2 : BMX DDO 1602
3 : BMX AMM 0600
Derived Data Types
Derived FB Types
Variables & FB instances
Elementary Variables
Derived Variables
Device DDT Variables
IO Derived Variables
Elementary FB Instances
Derived FB Instances
Motion
Communication
Networks
Ethernet_1
Programs
Tasks
MAST
Logic
SR Sections
Events
Timer Events
I/O Events
Animation Tables
Operator Screens
Documentation
PLC bus
Bus: 0
BMX PRA 0100 02.70
CPS 2000
PRA 0100
DDI 1602
DDO 1602
AMM 0600
Task: MAST
PLC bus
Ethernet_1
Data Editor
0.1 : BMX D...
0.2 : BMX D...
0.0 : Ethernet
Analyzing...
Project settings disabled : Maintain output links on disabled EF (EN=0)
[Ethernet_1] : [BMX PRA 0100 V2.7] Security has been enabled on this module (because some services like FTP or other ones are DISABLED).
Please ensure that the firmware version of the REAL module supports this feature.
Generating...
Linking...
Process succeeded : 0 Error(s) , 1 Warning(s)
Rebuild All Project
Import/export
User errors
FDT log event
Search/Replace
Ready
Tapez ici pour effectuer une recherche
HMI R/W mode EQUAL RUN UPLOAD INFO OK TCP/IP:10.10.5.61
MEM BUILT
12°C Nuageux


Unity Pro XL : <No name>*
Ethernet_1
Model Family
Module Address
Rack
Module
Channel
Module Utilities
SMTP
Module IP Address
IP Address
Subnetwork Mask
Gateway Address
Security
IP Configuration
Messaging
SNMP
SMTP
Bandwidth
IP address configuration
Configured
From a server
Ethernet configuration
BMX DDI 1602
Dig 16I 24 Vdc Sink Version : 2.0
Channel 0
Channel 8
Configuration
Debug
Function:
Discrete inputs
Task:
MAST
Supply monitoring
BMX DDO 1602
Dig 16Q Trans Source 0.5A Version : 2.0
Discrete outputs
Symbol
Fallback value
Analyzing...
Project settings disabled : Maintain output links on disabled EF (EN=0)
[Ethernet_1] : [BMX PRA 0100 V2.7] Security has been enabled on this module (because some services like FTP or other ones are DISABLED).
Please ensure that the firmware version of the REAL module supports this feature.
Generating...
Linking...
Process succeeded : 0 Error(s) , 1 Warning(s)
Rebuild All Project
Tapez ici pour effectuer une recherche
12°C Nuageux
DELL




Unity Pro XL : <No name>* - [PLC bus]
File Edit View Services Tools Build PLC Debug Window Help
Disconnect Ctrl+K
Set Address...
Standard Mode
Simulation Mode
Compare...
Transfer Project to PLC Ctrl+L
Transfer Project from PLC Ctrl+Shift+L
Transfer Project from Primary to StandBy PLC
Save Data from PLC to File
Restore Data from File to PLC
Safety/Maintenance Ctrl+Shift+M
Stop Ctrl+R
Init
Init Safety
Update Upload Information
Update Init Values with Current Values.
Update Local Init Values with PLC Init Values.
Project Backup...
Memory Consumption...
State Ram Viewer
Project Browser
Structural view
Project
Configuration
0 : PLC bus
0 : BMX XBP 0600
(P) (P) : BMX CPS 2000
0 : BMX PRA 0100
1 : BMX DDI 1602
2 : BMX DDO 1602
3 : BMX AMM 0600
4
5
Derived Data Types
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Derived Variables
Device DDT Variables
IO Derived Variables
Elementary FB Instances
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Timer Events
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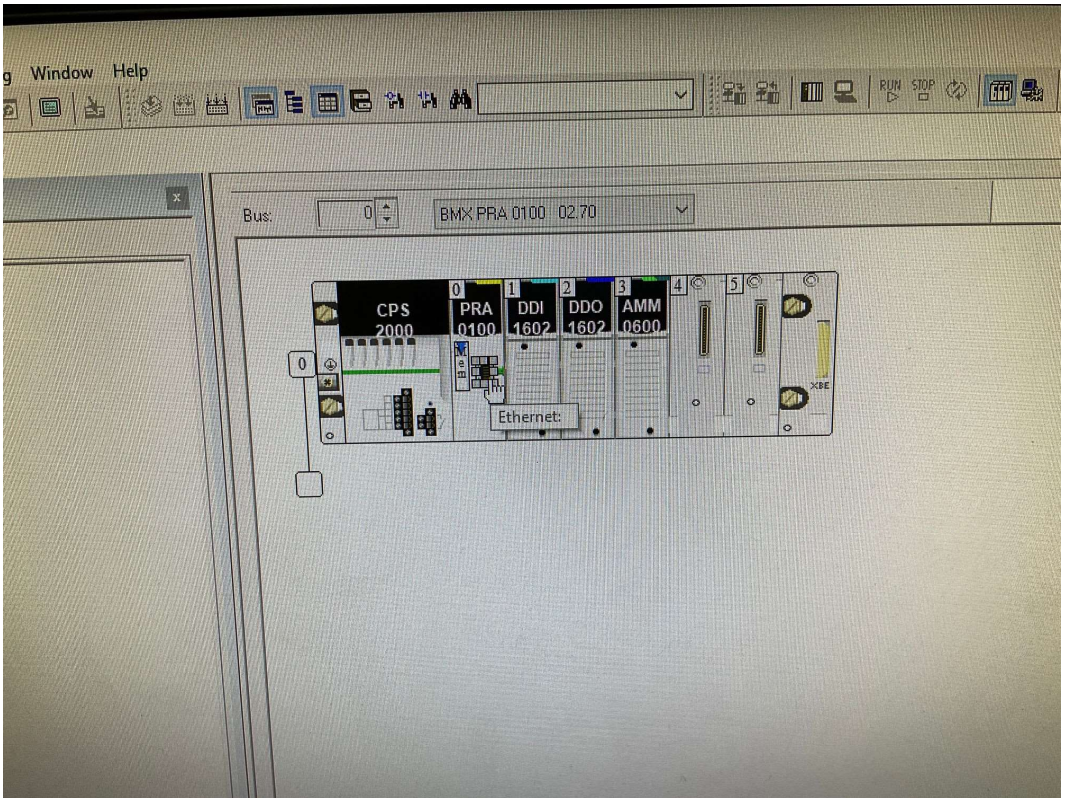
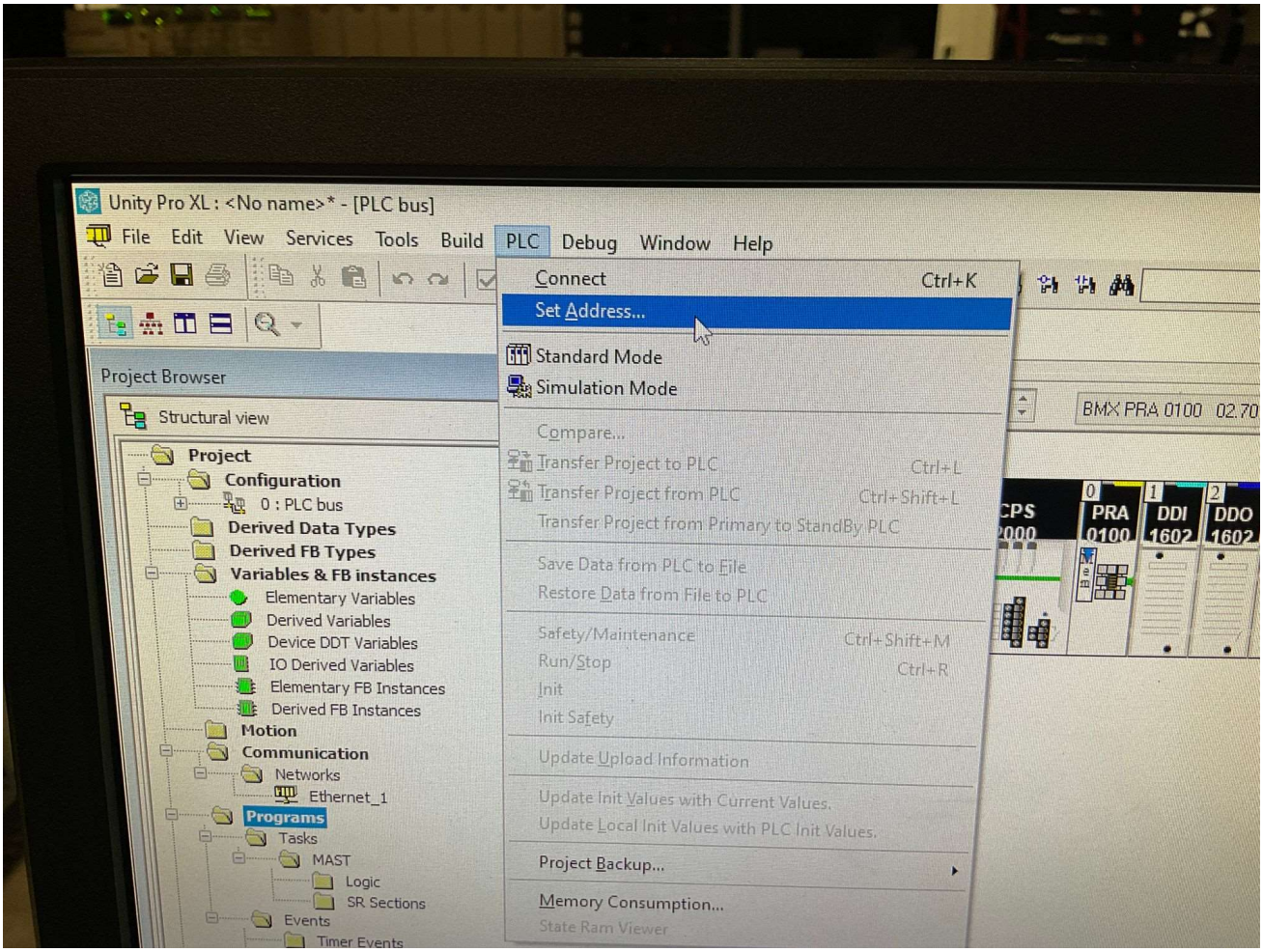
Animation Tables
Operator Screens
Documentation
BMX PRA 0100 02.70
PRA 0100
DDI 1602
DDO 1602
AMM 0600


Window Help
Bus:
0
BMX PRA 0100 02.70
CPS 2000
0 PRA 0100
1 DDI 1602
2 DDO 1602
3 AMM 0600
Ethernet:


Unity Pro XL : <No name>* - [PLC bus]
File Edit View Services Tools Build PLC Debug Window Help
Connect Ctrl+K
Set Address...
Standard Mode
Simulation Mode
Compare...
Transfer Project to PLC Ctrl+L
Transfer Project from PLC Ctrl+Shift+L
Transfer Project from Primary to StandBy PLC
Save Data from PLC to File
Restore Data from File to PLC
Safety/Maintenance Ctrl+Shift+M
Run/Stop Ctrl+R
Init
Init Safety
Update Upload Information
Update Init Values with Current Values.
Update Local Init Values with PLC Init Values.
Project Backup...
Memory Consumption...
State Ram Viewer
Project Browser
Structural view
Project
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0 : PLC bus
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Derived FB Types
Variables & FB instances
Elementary Variables
Derived Variables
Device DDT Variables
IO Derived Variables
Elementary FB Instances
Derived FB Instances
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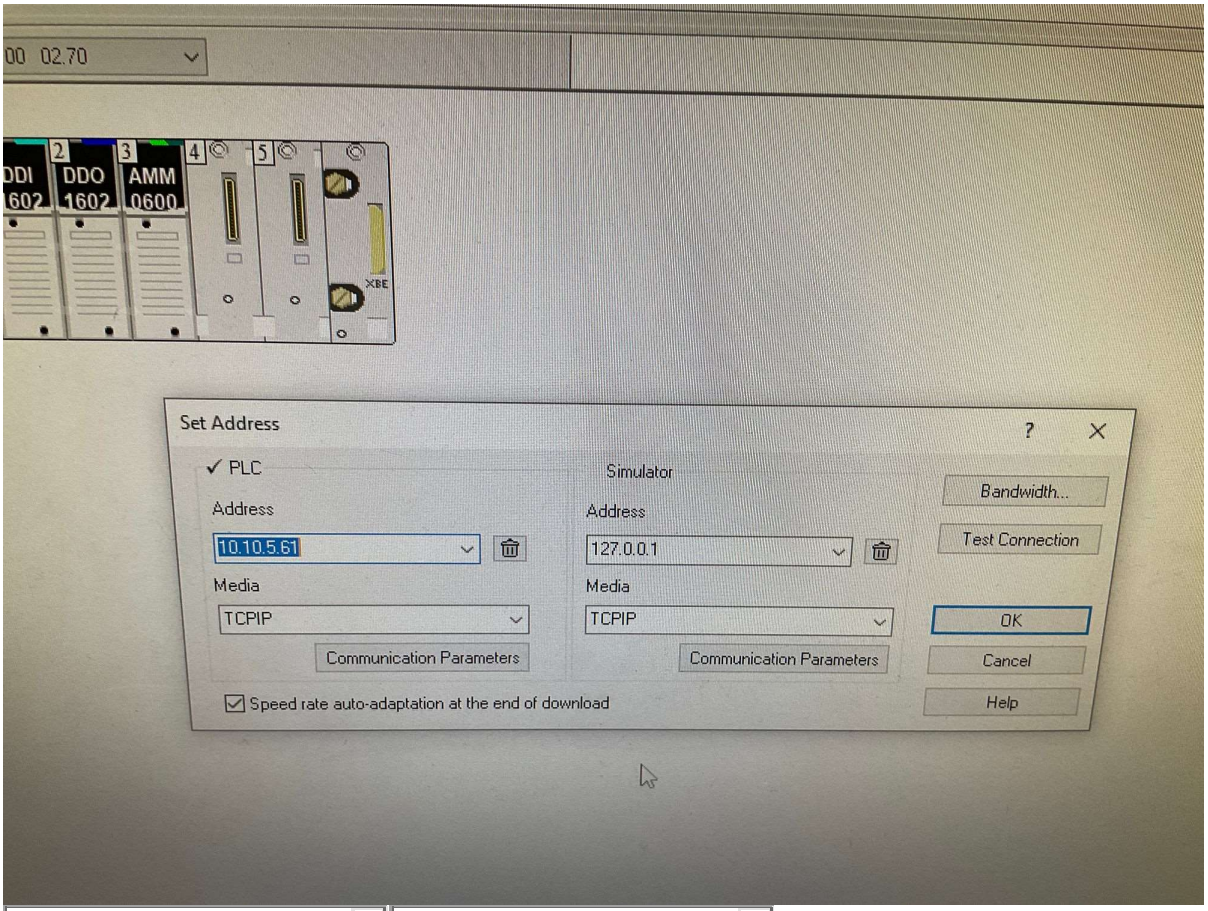
Ethernet_1
Programs
Tasks
MAST
Logic
SR Sections
Events
Timer Events
BMX PRA 0100 02.70
0 PRA 0100
1 DDI 1602
2 DDO 1602


00 02.70
2
DDO
1602
3
AMM
0600
4
5
XBE
Set Address
?
PLC
Simulator
Address
10.10.5.61
Media
TCPIP
Communication Parameters
Address
127.0.0.1
Media
TCPIP
Communication Parameters
Bandwidth...
Test Connection
OK
Cancel
Help
Speed rate auto-adaptation at the end of download

-