SCADA TIA Portal - Conectivitate

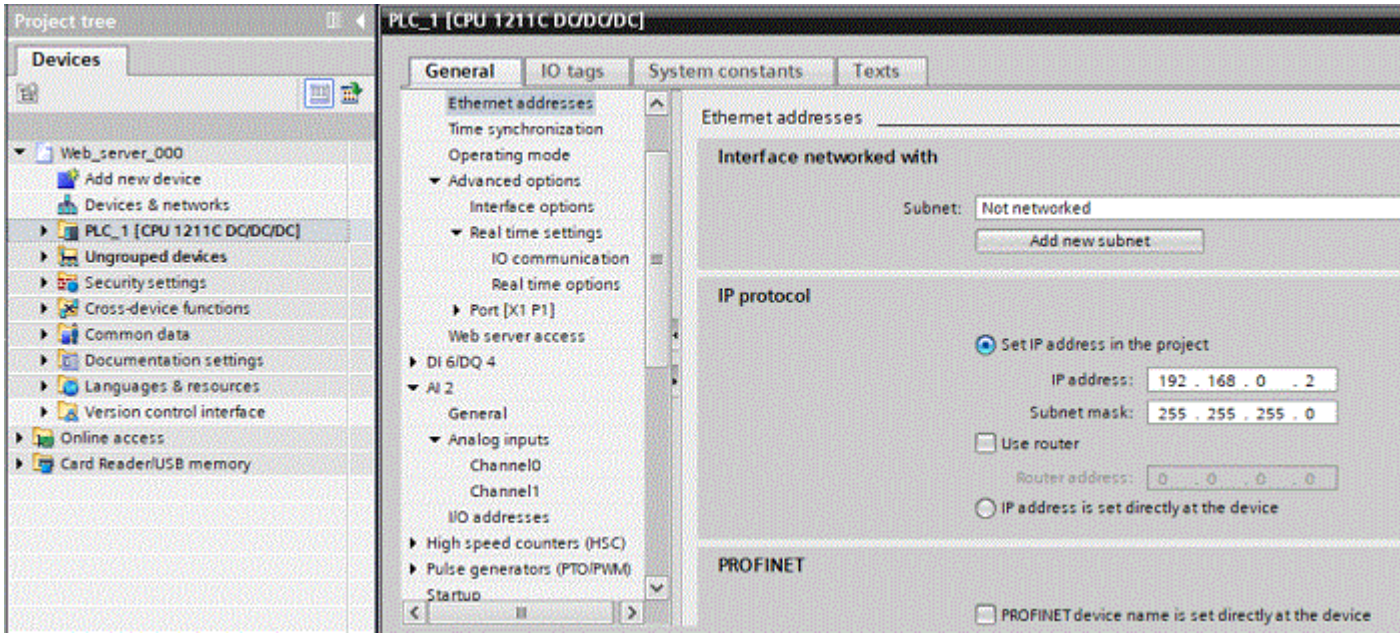
- **Obiective**
  - Configurare Web Server
  - Realizarea de aplicatii Web Server
  - Conectarea la o baza de date SQL
  - Open Platform Communications (OPC)
- **Organizarea sarcinilor de lucru**
  - Parcurgeti cele trei capitole ale cursului.
  - In cadrul fiecarui capitol urmariti exemplele ilustrative si incercati sa le realizati in medul de dezvoltare "Citect".
  - Fixati principalele idei ale cursului, prezentate în rezumat.
  - Completati testul de autoevaluare.
  - Timpul de lucru pentru parcurgerea testului de autoevaluare este de 15 minute.

1.Web Server

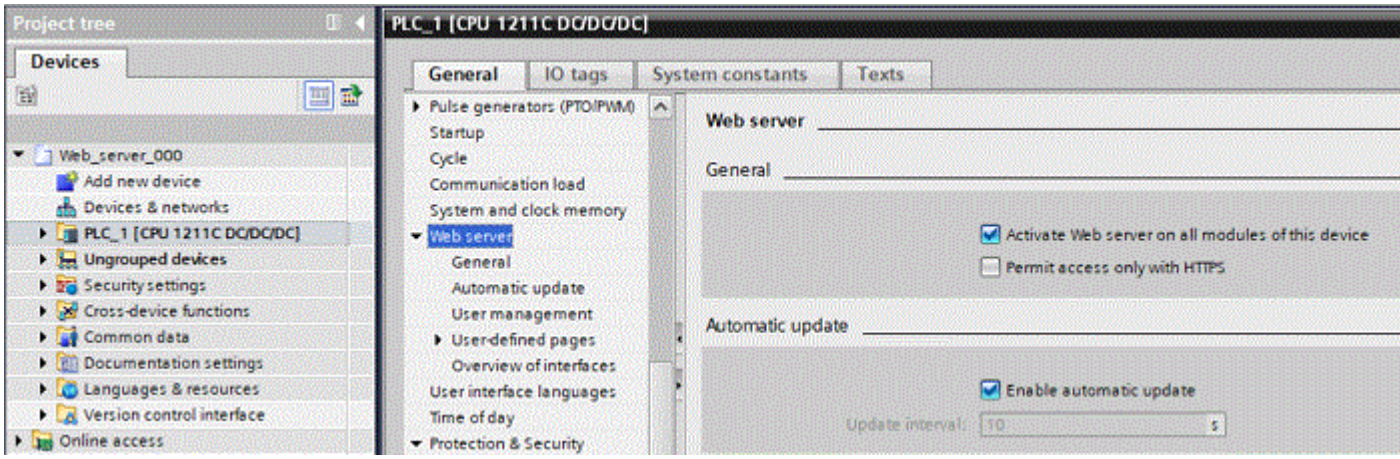
Configurare Web Server

Vom dezvolta in continuare proiectul numit **Web_server_000**
In cadrul acestui proiect se va configura un WebServer care va furniza paginile web din folder-ul: **Web_pages**

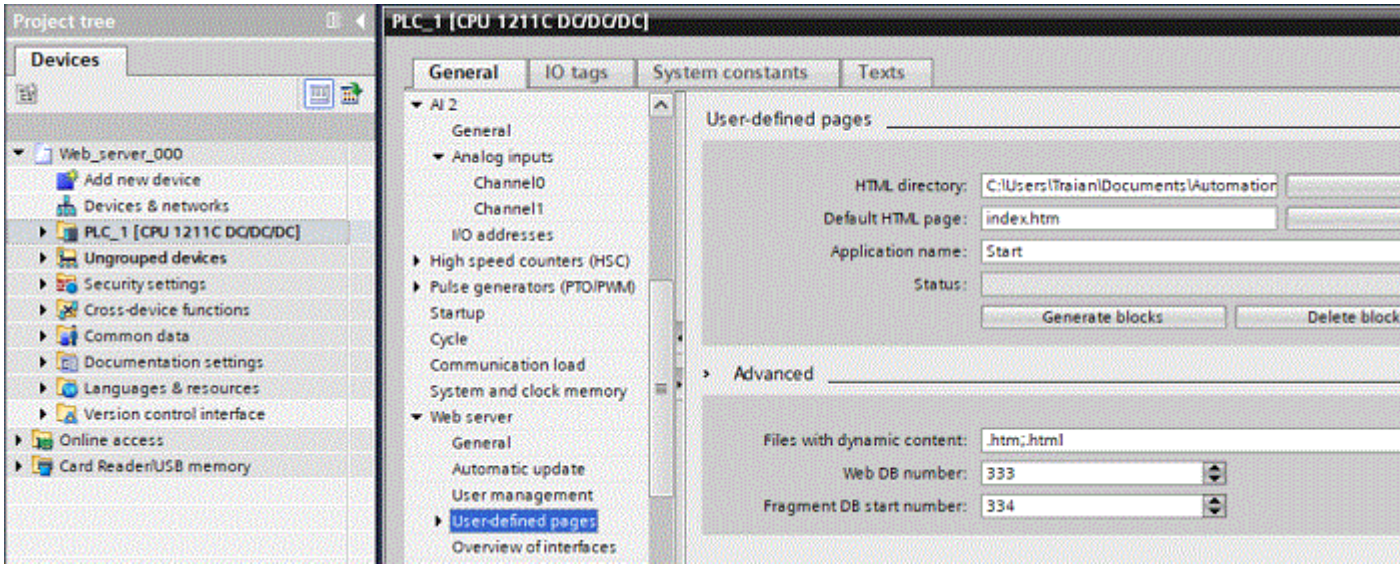
Configurare PROFINET Interface --> Ethernet adressses



Configurare Web Server ---> General

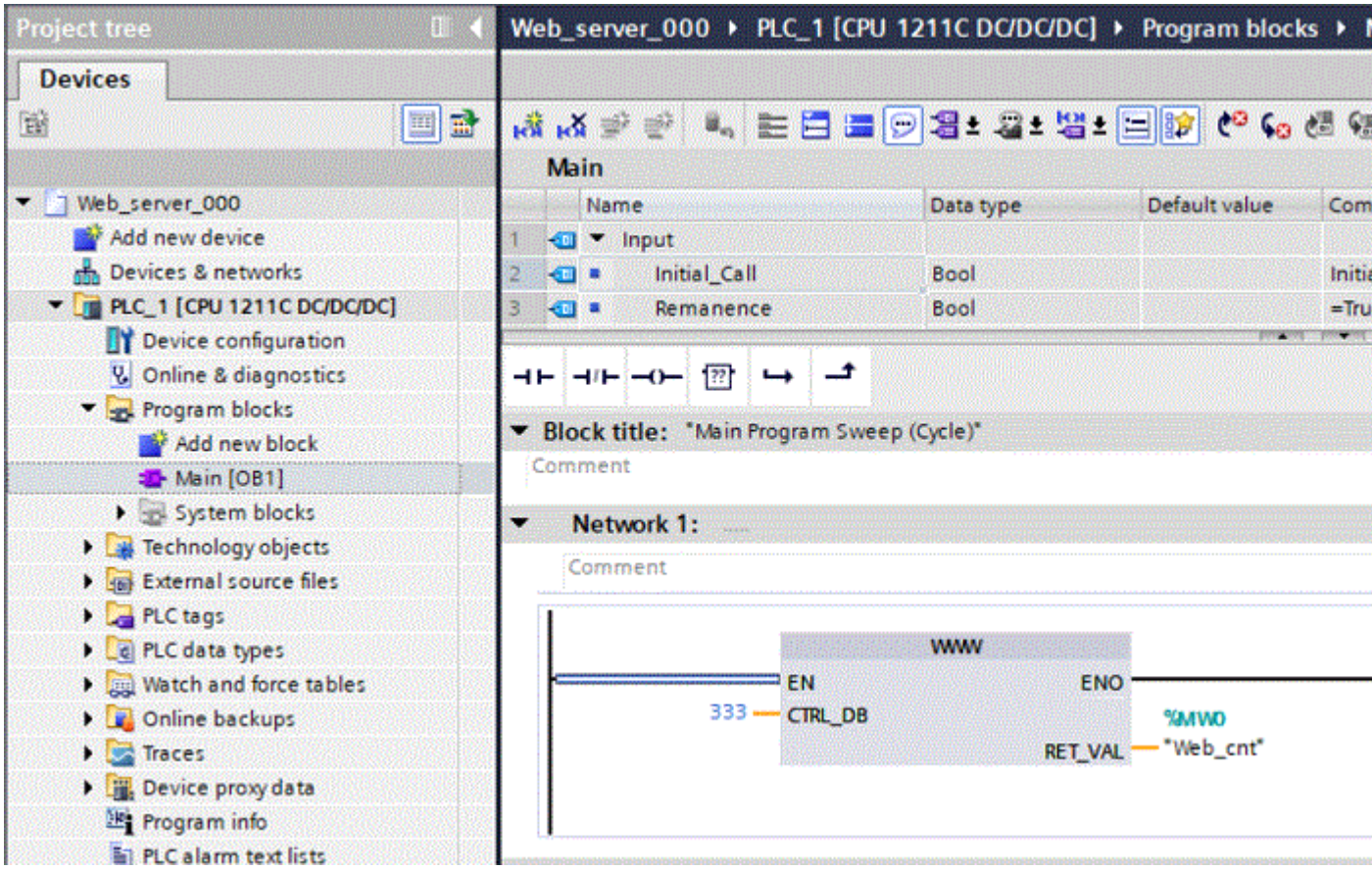


Configurare Web Server --> User Defined pages



Aplicatii Web Server

Program blocks --> Main

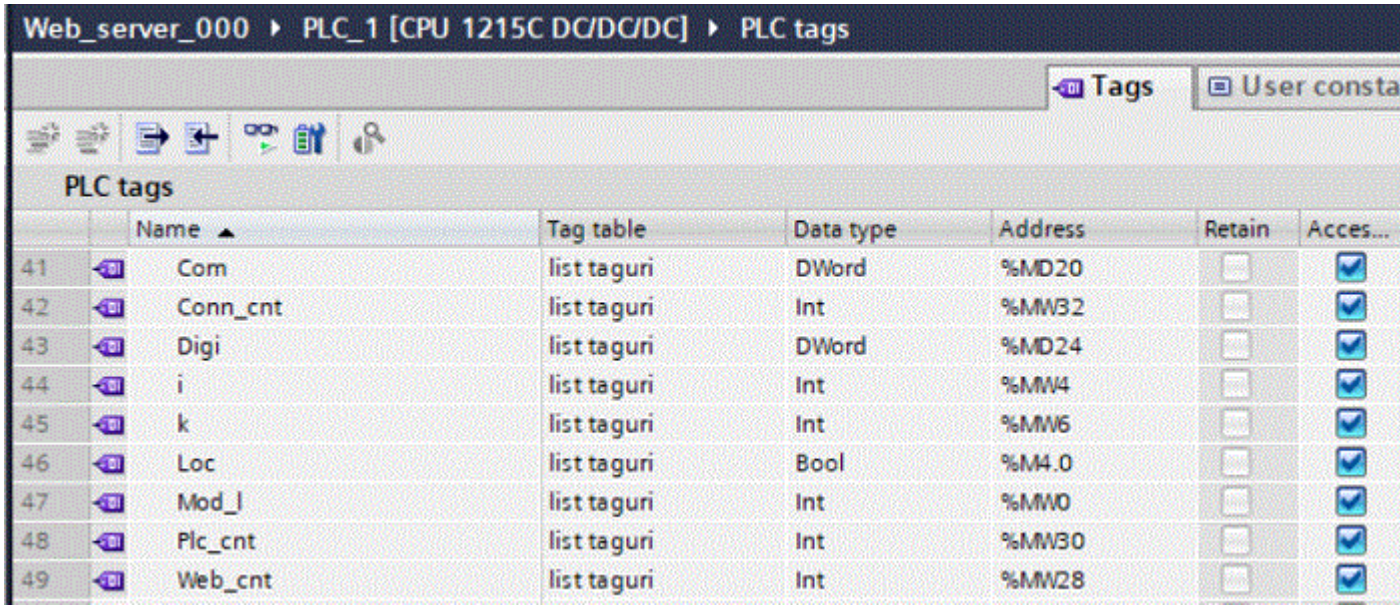


Definirea Tag-urilor

Vom defini:

- 8 TAG-uri PLC de tip bool-ean, cu numele B00 - B07 aflate pe intrarile digitale DIGITAL INPUT 0.0 - 0.7
- 8 TAG-uri PLC de tip bool-ean, cu numele B08 - B15 aflate pe intrarile digitale DIGITAL INPUT 1.0 - 1.7.
- 8 TAG-uri PLC de tip bool-ean, cu numele C00 - C07 aflate pe iesirile digitale DIGITAL OUTPUT 0.0 - 0.7.
- 8 TAG-uri PLC de tip bool-ean, cu numele C08 - C15 aflate pe iesirile digitale DIGITAL OUTPUT 1.0 - 1.7.

Vom mai defini tag-urile:



	Name	Tag table	Data type	Address	Retain	Acces...
41	Com	list taguri	DWord	%MD20		
42	Conn_cnt	list taguri	Int	%MW32		
43	Digi	list taguri	DWord	%MD24		
44	i	list taguri	Int	%MW4		
45	k	list taguri	Int	%MW6		
46	Loc	list taguri	Bool	%M4.0		
47	Mod_I	list taguri	Int	%MW0		
48	Plc_cnt	list taguri	Int	%MW30		
49	Web_cnt	list taguri	Int	%MW28		

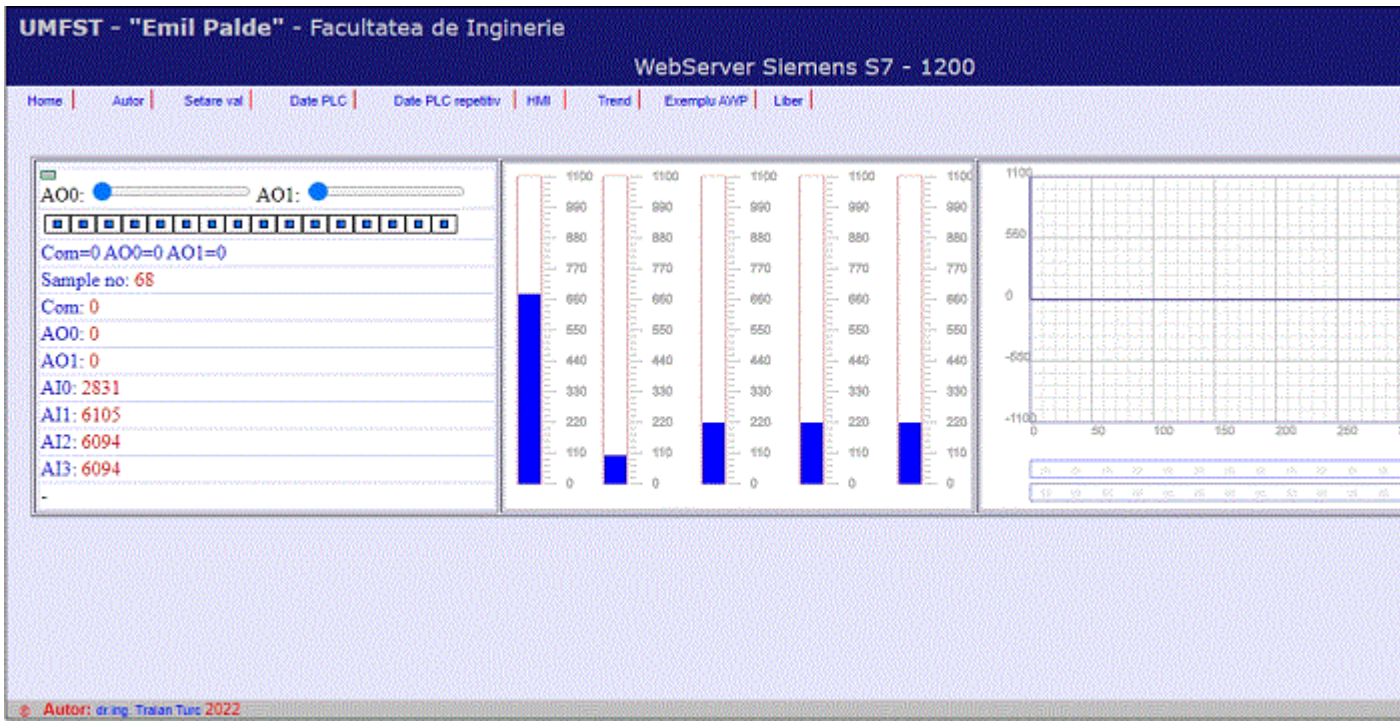
Pentru a realiza pagini Web in care sa accesam mai eficient Tag-urile de mai sus, vom crea un Program Blocks -- Cyclic Intrrupt in care vom codifica binar-zecimal toate intrarile binare B01-B15 precum si iesirile digitale C00-C15, pentru a face mai eficienta comunicarea intre PLC si paginile web.

```
"Plc_cnt" := "Plc_cnt" + 1;
IF "Plc_cnt" > 100 THEN
    "Plc_cnt" := 0;
    ;
END_IF;

// Calculez valoarea "Digi"

"Digi" := 0;
IF "B00" THEN
    "Digi" := "Digi" + 1;
END_IF;
IF "B01" THEN
    "Digi" := "Digi" + 2;
END_IF;
IF "B02" THEN
    "Digi" := "Digi" + 4;
END_IF;
IF "B03" THEN
    "Digi" := "Digi" + 8;
END IF;
IF "B04" THEN
    "Digi" := "Digi" + 16;
END_IF;
IF "B05" THEN
    "Digi" := "Digi" + 32;
END_IF;
IF "B06" THEN
    "Digi" := "Digi" + 64;
END_IF;
```

```
IF "B07" THEN
    "Digi" := "Digi" + 128;
END_IF;
IF "B08" THEN
    "Digi" := "Digi" + 256;
END_IF;
IF "B09" THEN
    "Digi" := "Digi" + 512;
END_IF;
IF "B10" THEN
    "Digi" := "Digi" + 1024;
END_IF;
IF "B11" THEN
    "Digi" := "Digi" + 2048;
END_IF;
IF "B12" THEN
    "Digi" := "Digi" + 4096;
END_IF;
IF "B13" THEN
    "Digi" := "Digi" + 8192;
END_IF;
IF "B14" THEN
    "Digi" := "Digi" + 16384;
END_IF;
IF "B15" THEN
    "Digi" := "Digi" + 32768;
END_IF;

// Activez cele doua led-uri

"k" := "k" + 1;
IF "k" > 10 THEN
    "k" := 1;
END_IF;
IF ("k" MOD 2) = 0 THEN
    "C16" := TRUE;
    "C17" := FALSE;
ELSE
    "C16" := FALSE;
    "C17" := TRUE;
END_IF;

// Actualizez C0-C15  din valoarea "Com"
IF (NOT "Loc") THEN
    #vl := "Com";
    FOR #j := 0 TO 15 DO
        IF (#vl MOD 2) = 0 THEN
            #b := FALSE;
        ELSE
            #b := TRUE;
        END_IF;
        #vl := #vl / 2;
        CASE #j OF
            0:
                "C00" := #b;
            1:
                "C01" := #b;
            2:
                "C02" := #b;
            3:
```

```
                "C03" := #b;
            4:
                "C04" := #b;
            5:
                "C05" := #b;
            6:
                "C06" := #b;
            7:
                "C07" := #b;
            8:
                "C08" := #b;
            9:
                "C09" := #b;
            10:
                "C10" := #b;
            11:
                "C11" := #b;
            12:
                "C12" := #b;
            13:
                "C13" := #b;
            14:
                "C14" := #b;
            15:
                "C15" := #b;
        END_CASE;
    END_FOR;
END_IF;
```

Vom realiza in continuare o pagina Web care acceseaza tag-urile definite.



Paginile web sunt realizate in HTML si AWP(Automation Web Programming). Comenzile AWP sunt inserate sub forma de comentarii HTML. Comenzile AWP pot fi plasate în orice

pozitie din fisierul HTML. Cu toate acestea, din motive de claritate, se recomanda plasarea comenzilor AWP la inceputul fisierului HTML.

Formatul comenzii AWP pentru declararea unei variabile:

```
<!-- AWP_In_Variable Name='"Nume_var"' -->
```

Toate variabilele transferate spre CPU trebuie sa fie definite ca **AWP_In_Variable**.
Variabila este scrisa intre ghilimele duble si incadrate in ghilimele simple ('" … " ').
Toate variabilele citite din CPU trebuie sa aiba forma:

```
:="Nume_var":
```

Sa presupunem ca avem definite PLC Tag-urile:Com, AO0, AO1.
Pagina web **set_val.html**, care permite modificarea Tag-urilor Com, AO0, AO1 va fi:

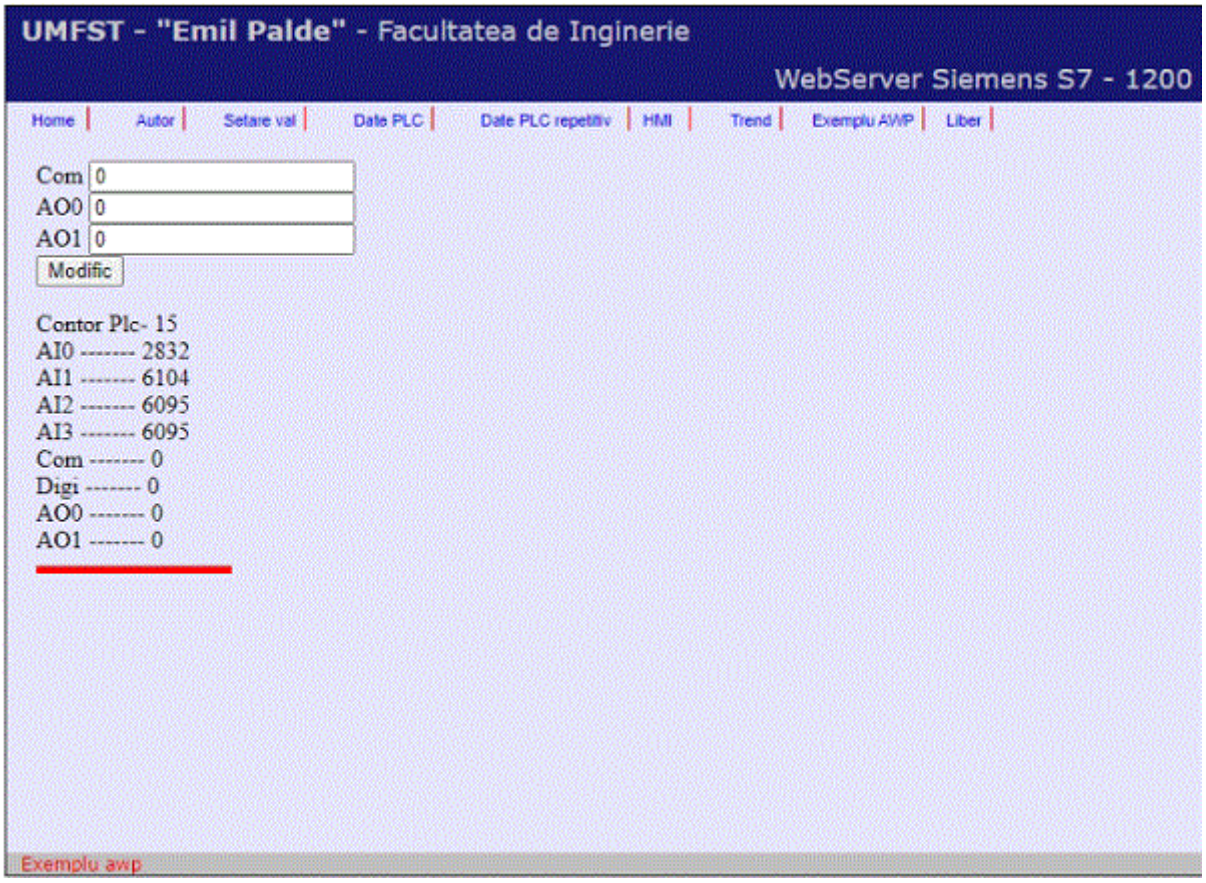
```
<!-- AWP_In_Variable Name='"Com"' -->
<!-- AWP_In_Variable Name='"AO0"' -->
<!-- AWP_In_Variable Name='"AO1"' -->

&ltform method="get" action="set_val.html">
        &ltinput type="submit" value="Modific">
        Com &ltinput type="text" name='"Com"'value=':="Com":'>
        AO0 &ltinput type="text" name='"AO0"'value=':="AO0":'>
</form>
```

Pagina **date_v0.html** este un exemplu simplu in care se modifica respectiv se afiseza vlorile controlate de PLC prin intermediul Tag-urilor definite mai sus.

0
AO0 0
AO1 0
Modific
Contor Plc- :="Plc_cnt":
AI0 ------- :="AI0":
AI1 ------- :="AI1":
AI2 ------- :="AI2":
AI3 ------- :="AI3":

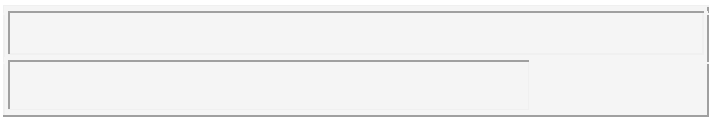
Com ------- :="Com":
Digi ------- :="Digi":
AO0 ------- :="AO0_w":
AO1 ------- :="AO1_w":

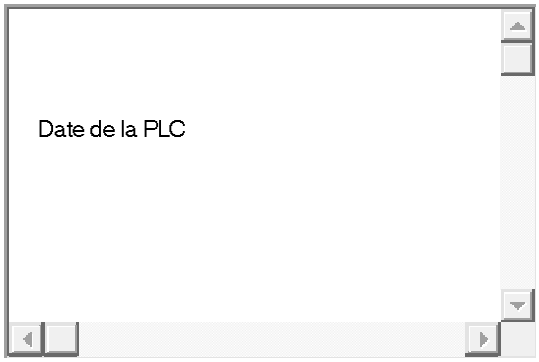
Afisarea acestei pagini se va face utilizand orice browser in care se apeleaza url-ul:
http://192.168.0.11/awp//index.htm



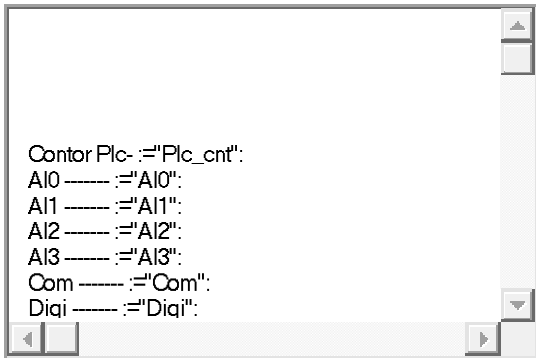
Datele provenite de la PLC sunt dinamice. Pentru a afisa un nou set de date pagina trebuie reincarcata.

Aplicatia **date_r.html** afiseaza repetitiv datele provenite de la PLC





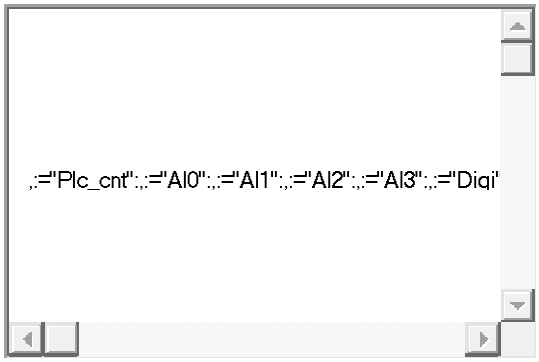
Continutul **date_v1.html** find:



Aplicatia **date_r.html**afiseaza dinamic datele de la PLC insa dezavantajul este ca pagina "clipeste" la fiecare reincarcare.

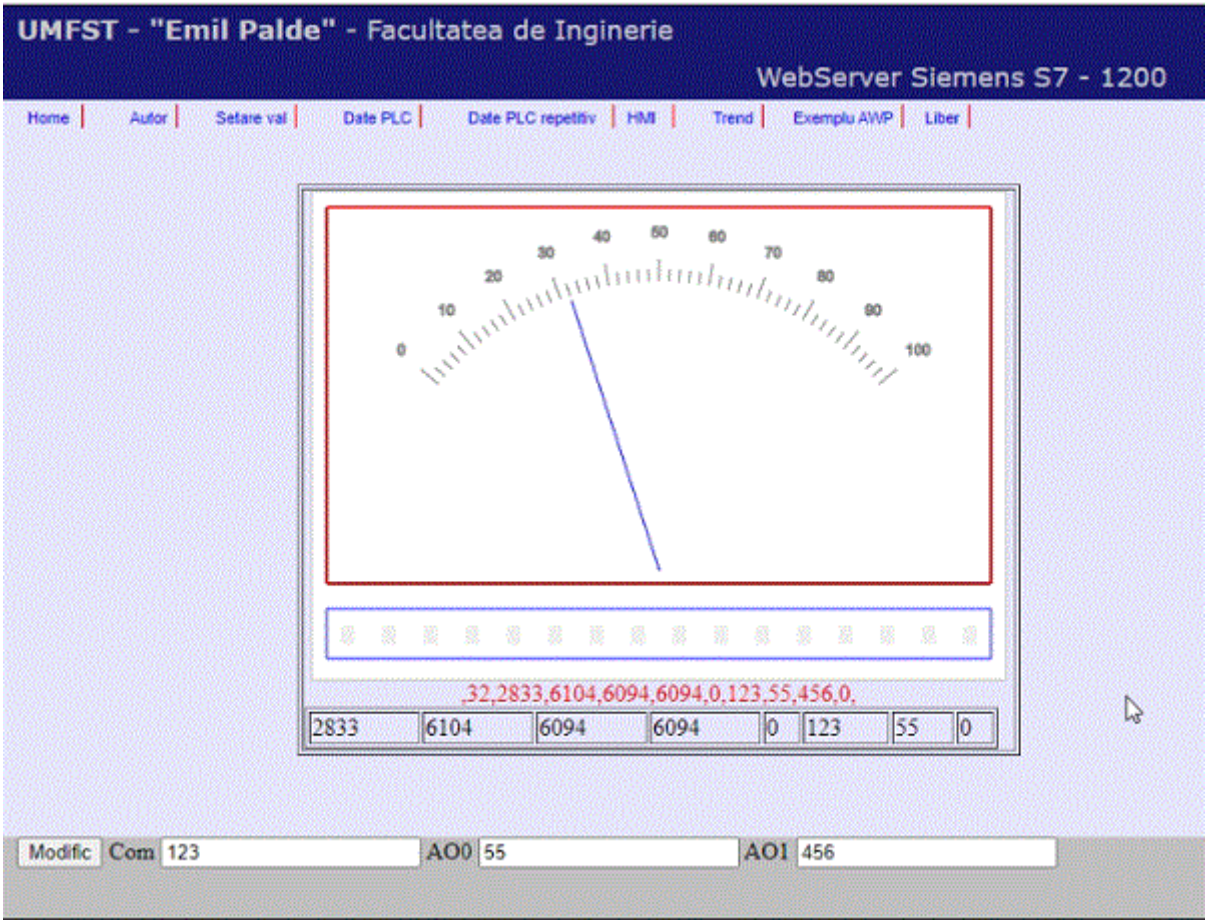
Cel mai potrivit ar fi sa folosim tehnologia "Ajax" si sa aducem repetitiv numai datele nemaifiid necesara reincarcarea paginii.

Vom crea pagina **date.html** care trimite datele in vederea preluarii acestora prin tehnologia "Ajax"



Dupa cum se observa valorile Tag-urilor "Plc_cnt","AI0","AI1","AI2","AI3","Digi","Com","AO0_w","AO1_w","Conn_cnt" sunt trimise sub forma de text delimitate prin separatorl ",".

Aplicatia **hmi_ajax.html** afiseaza dinamic valorile primite de la PLC.



Your browser does not support the HTML5 canvas tag.

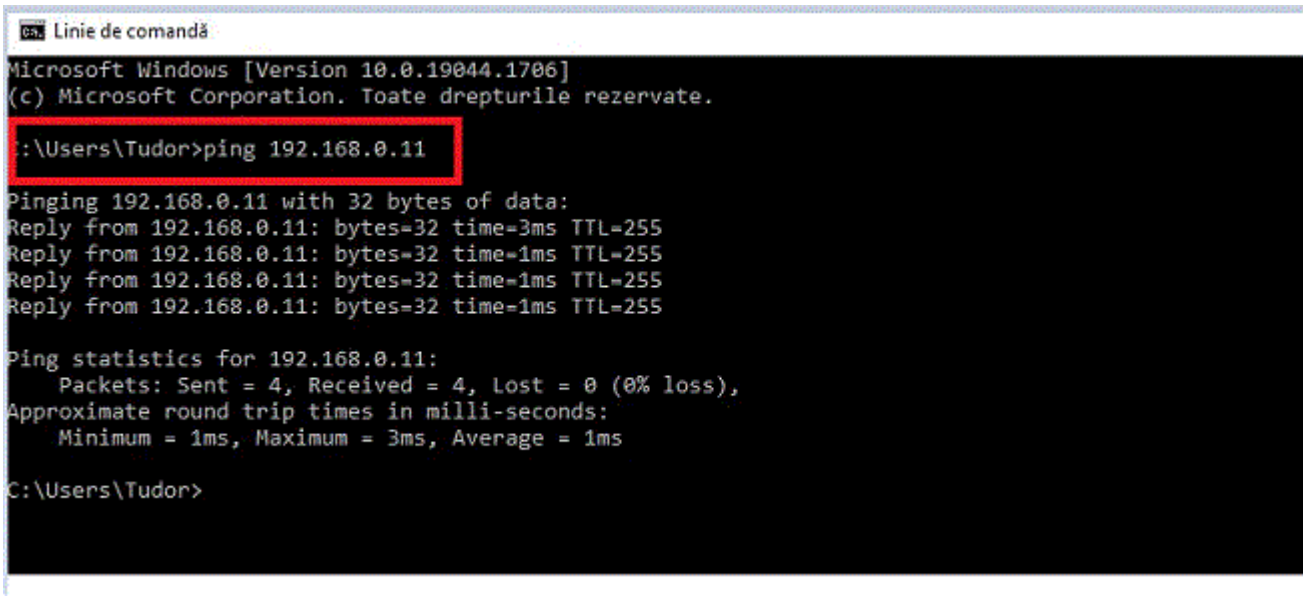
Clasa voltm fiind: voltm Exemplu de utilizare: ex1

2. conexiune OPC

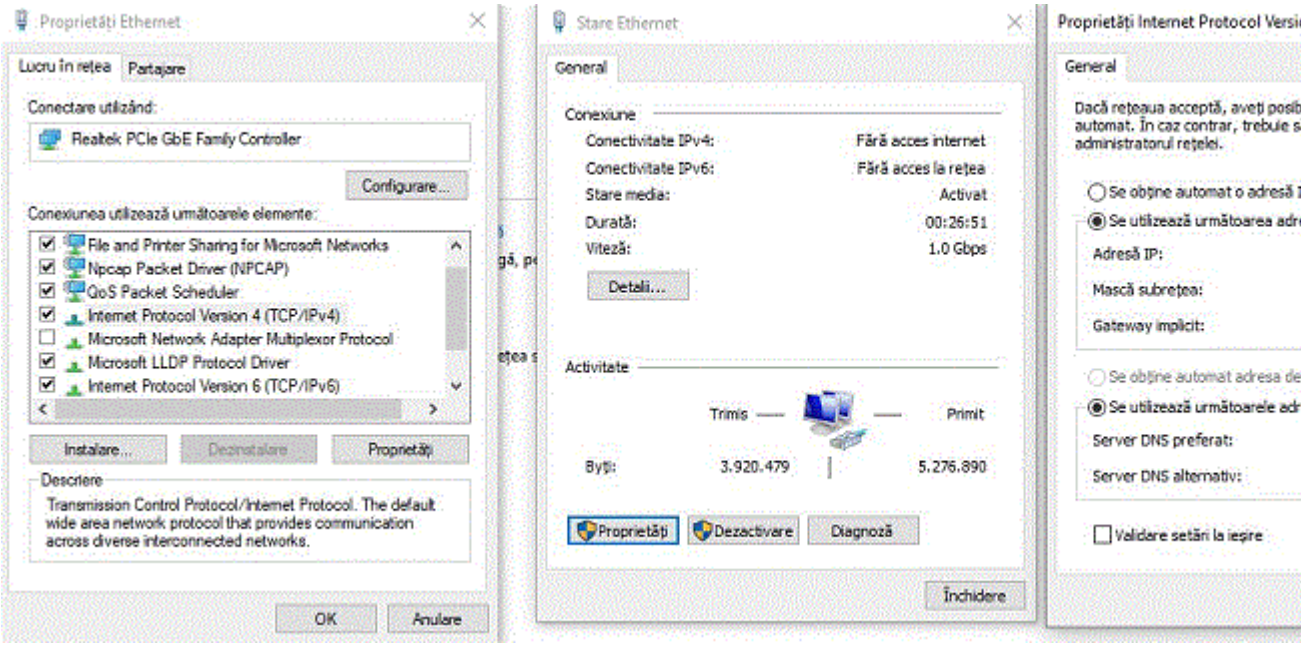
Capitol realizat cu contributia asist: Tudor Covrig

Configurare IP Calculator

- Se verifica daca PC se afla in aceea?i retea cu PLC-ul:

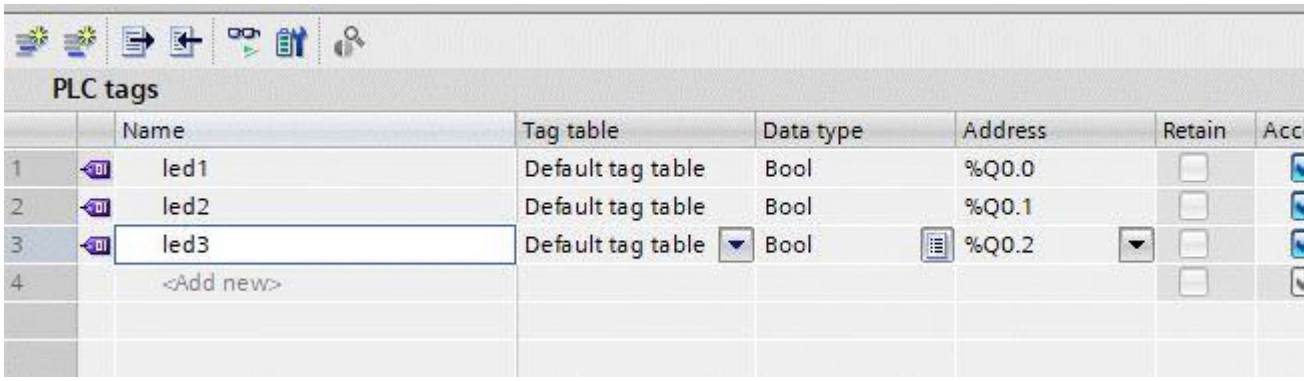


- Daca cele doua nu sunt in aceeasi retea, se modifica adresa IP a calculatorului:

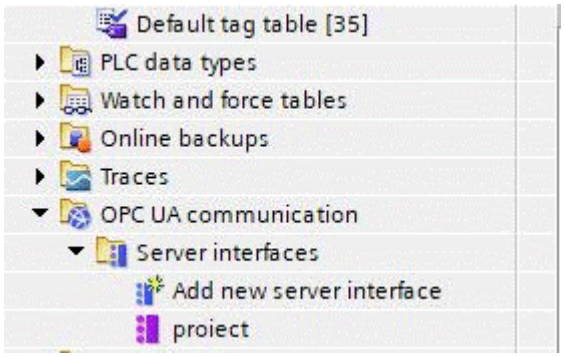


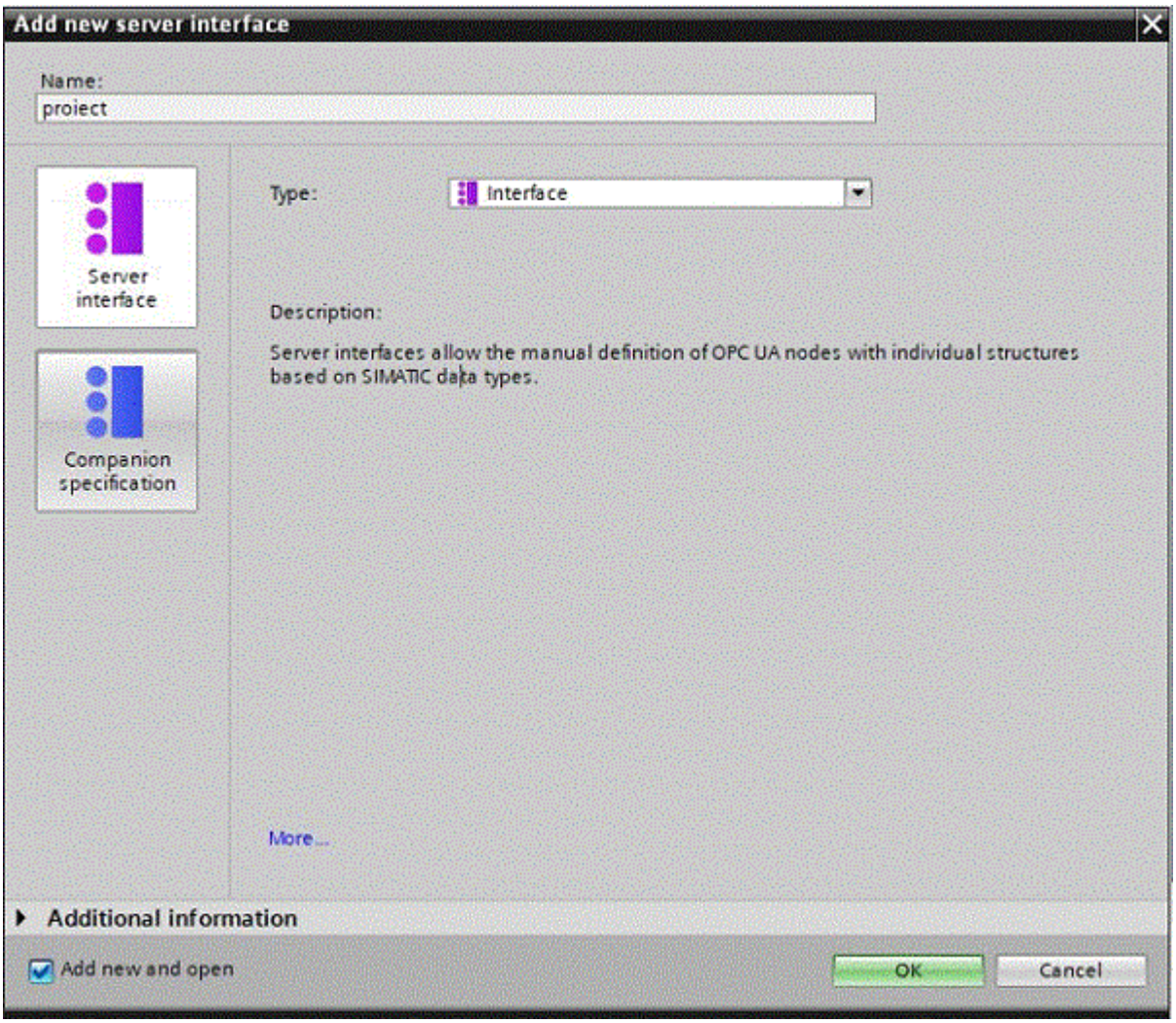
Configurare OPC

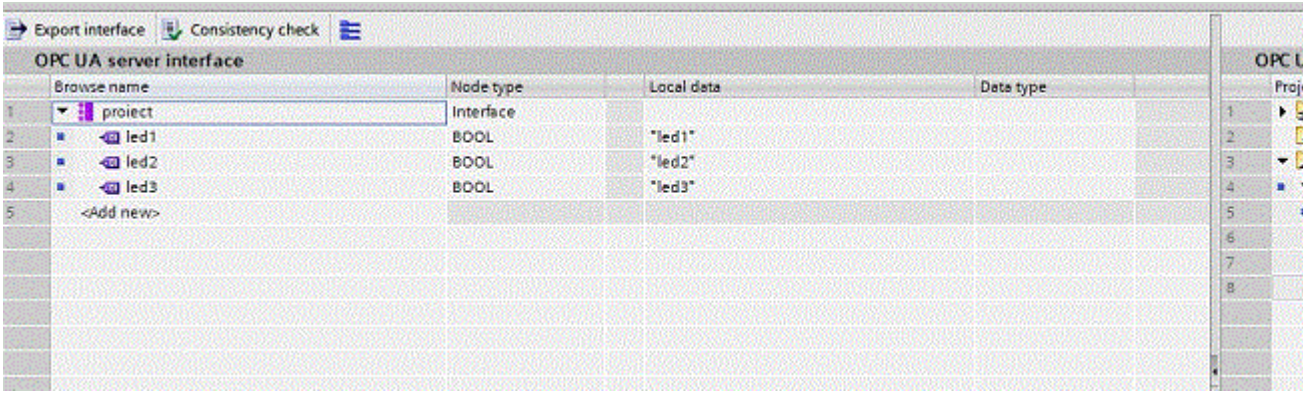
- Se creaza variabilele tag care urmeaza sa fie exportate:



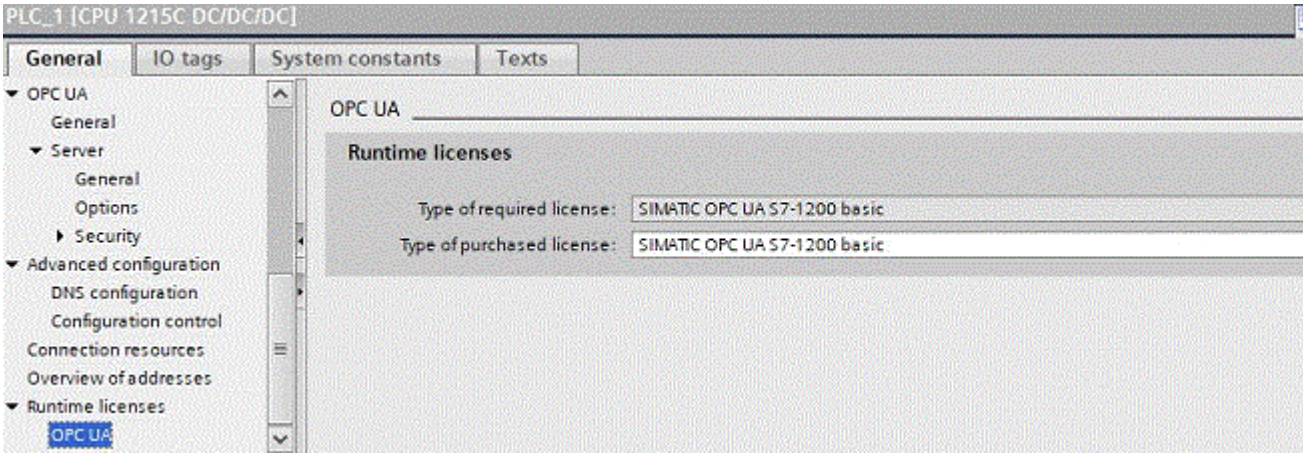
- Se adauga un nou tabel in care se salveaza variabilele pe care dorim sa le exportam





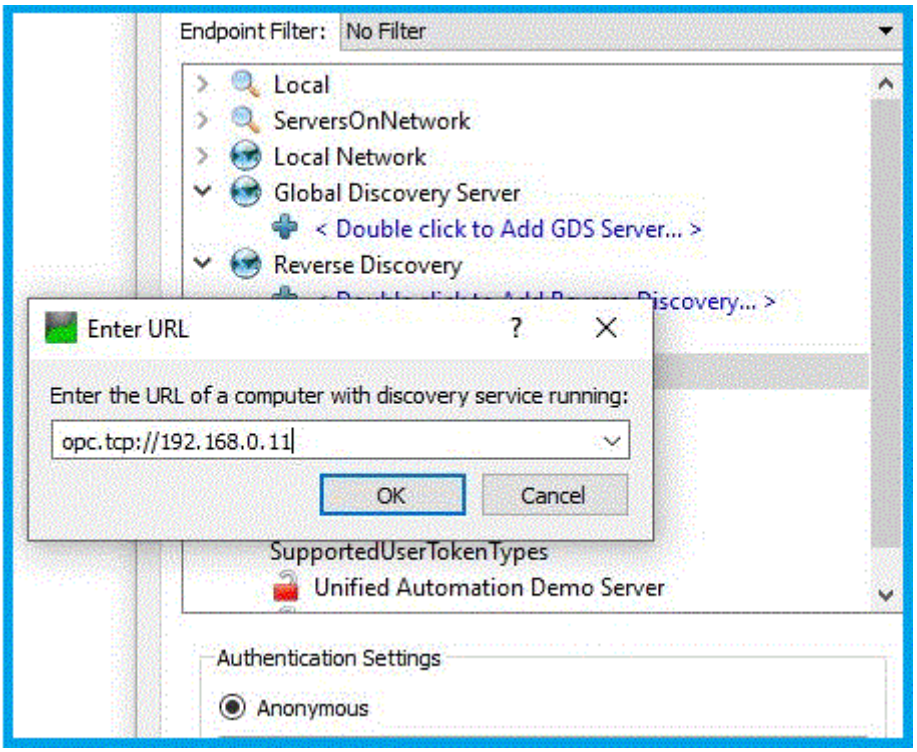


- Se activeaza licenta OPC si se incarca programul în PLC:

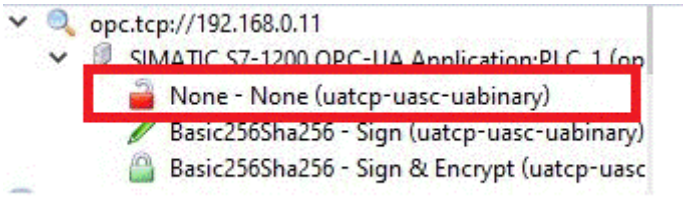


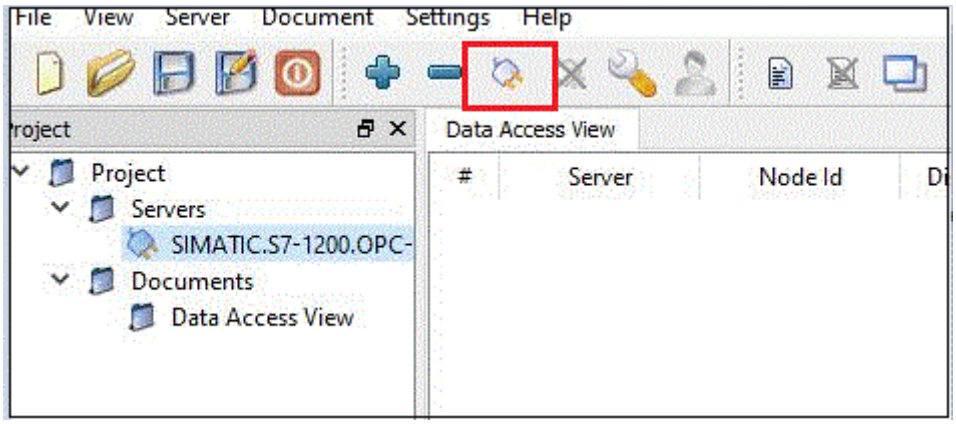
Instalarea aplicatiei UaExpert

- Se descarca aplicatia UaExpert
- Se ruleaza aplicatia si se selecteaza meniul „Add server” dupa care se adauga adresa IP a PLC-ului cu care dorim sa comunicam.

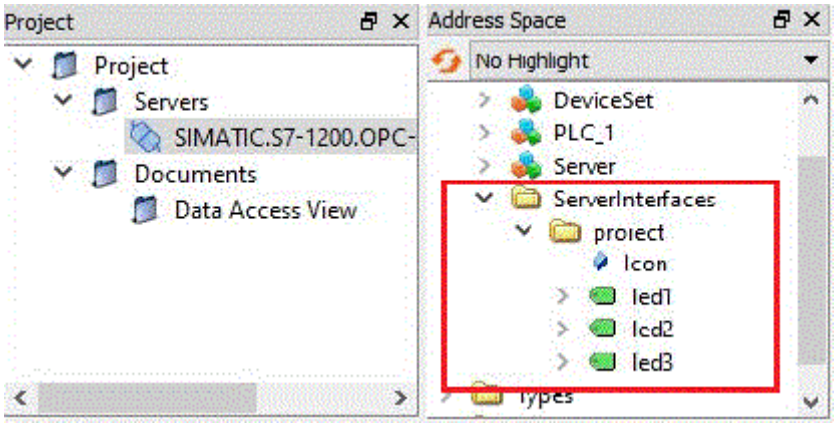


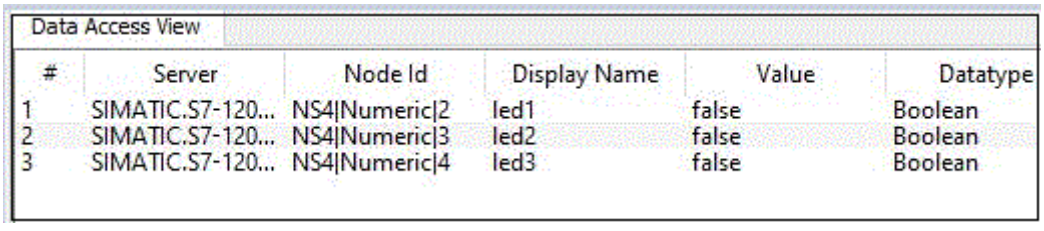
- Se selecteaza „None-None (uatcp-uasc-uabinary) ?i „Connect Server”:





- Se selecteaza „ServerInterfaces”, folderul cu denumirea tabelului ce contine variabilele exportat din PLC („proiect”) dupa care se copiaza variabilele in meniul „Data Access View”. In final, starea acestor variabile poate fi modificata, iar schimbarea este vizibila în PLC.





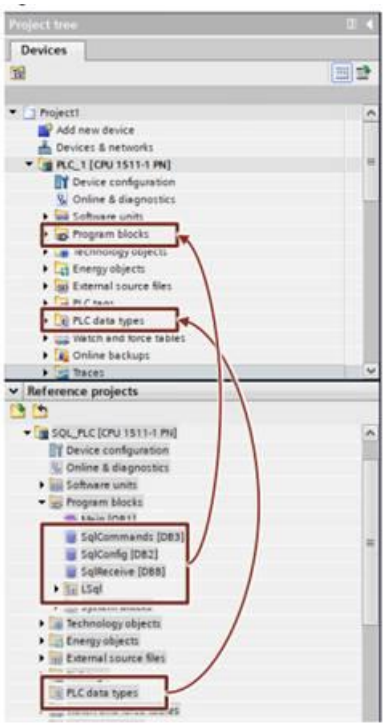
3. Conectarea PLC-ului la baza de date de tip SQL

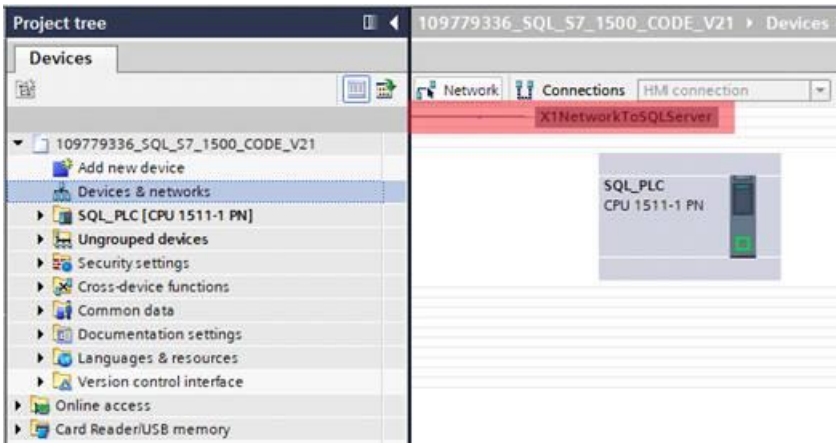
Capitol realizat cu contributia stud:Iordache Andrada-Bianca- AIA IV

Se va realiza in continuare conectarea PLC-ului Siemens S7-1200 la o baza de date de tip SQL. Pentru a realiza conectarea s-a utilizat libraria LSql, care poate fi descarcata de la adresa: https://support.industry.siemens.com/cs/document/109779336/connecting-a-s7-1200-s7-1500-to-a-sql-database-?dti=0&lc=en-WW

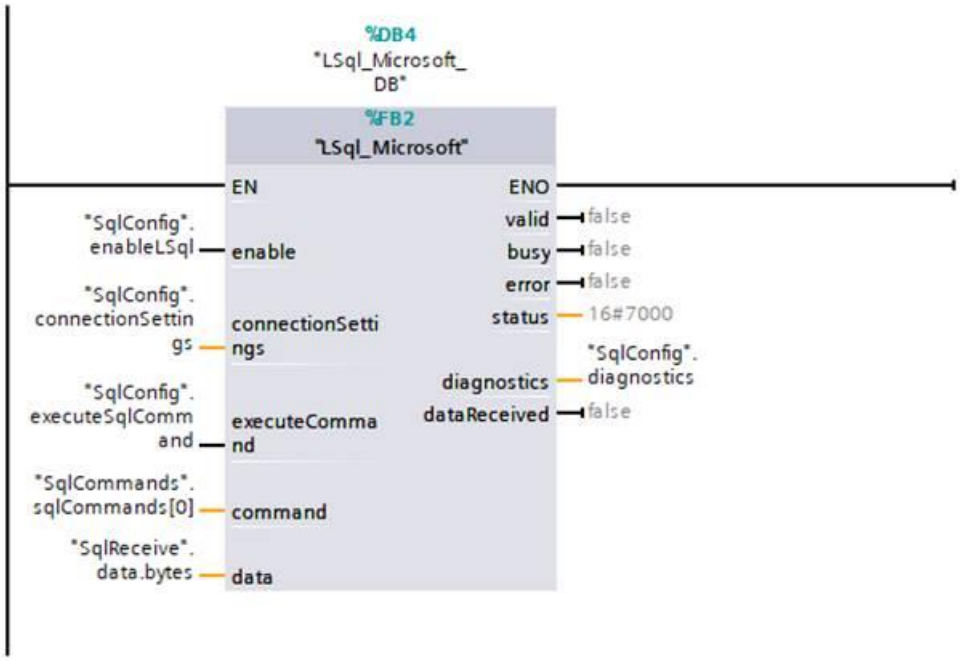
Configurarea PLC-ului:

1. Se descarca libraria LSql
2. Se creeaza un nou proiect in TIA Portal, unde se adauga configuratia PLC-ului. In paralel se dezarhiveaza proiectul descarcat si se deschide. Din proiectul descarcat se copiaza urmatoarele elemente in noul proiect creat:
    - "LSql" block folder
    - Data block "SqlConfig"
    - Data block "SqlCommand"
    - Data block "SqlReceive"
    - PLC data types folder
    - X1NetworkToSQLServer (din meniul Device and Networks)



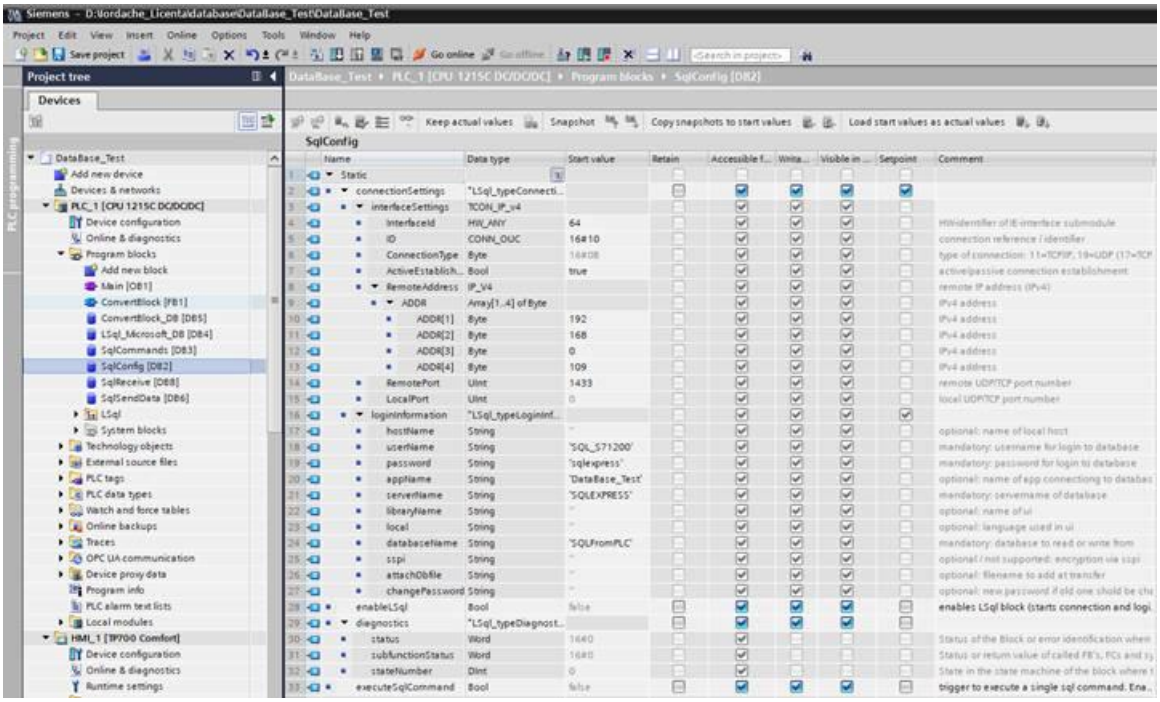


3. Blocul LSql_Microsoft este apelat intr-un block ciclic (de exemplu Main) si se conecteaza intrarile si iesirile conform figurii urmatoare:



Acest bloc este controlat prin intermediul intrarilor "enableLSql" si "executeSqlCommand". Astfel cand intrarea "enableLSql" este setata "TRUE" se realizeaza conexiunea la baza de date iar cand "executeSqlCommand" este setata "TRUE" se executa query-ul selectat.

4. Se seteaza urmatorii parametrii in blocul de date SqlConfig:



Configurarea Server-ului Microsoft SQL Server Express

Se descarca si se instaleaza Microsoft SQL Server Express basics de la adresa:

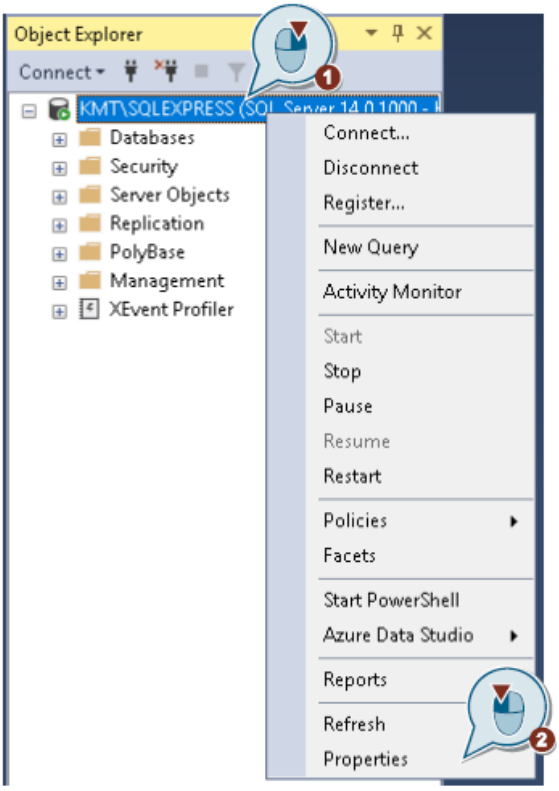
https://www.microsoft.com/en-US/download/details.aspx?id=55994

Se descarca si se instaleaza Microsoft SQL Server Management Studio

https://docs.microsoft.com/en-us/sql/ssms/download-sql-server-management-studio-ssms?view=sql-server-ver15

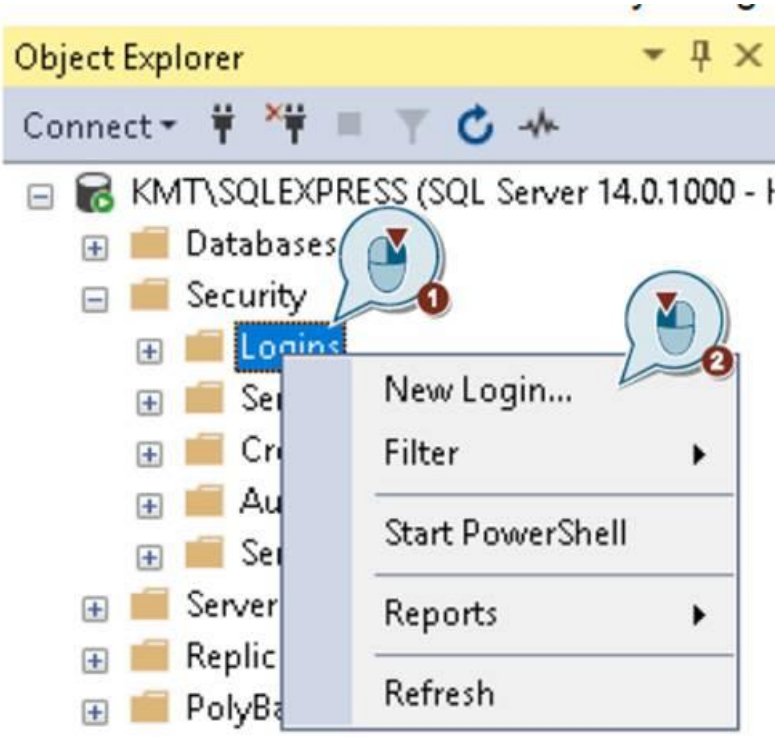
Loggarea in SQL server

1. Porniti Microsoft SQL Server Management Studio
2. Deschideti meniul "Properties" a SQLEXPRESS



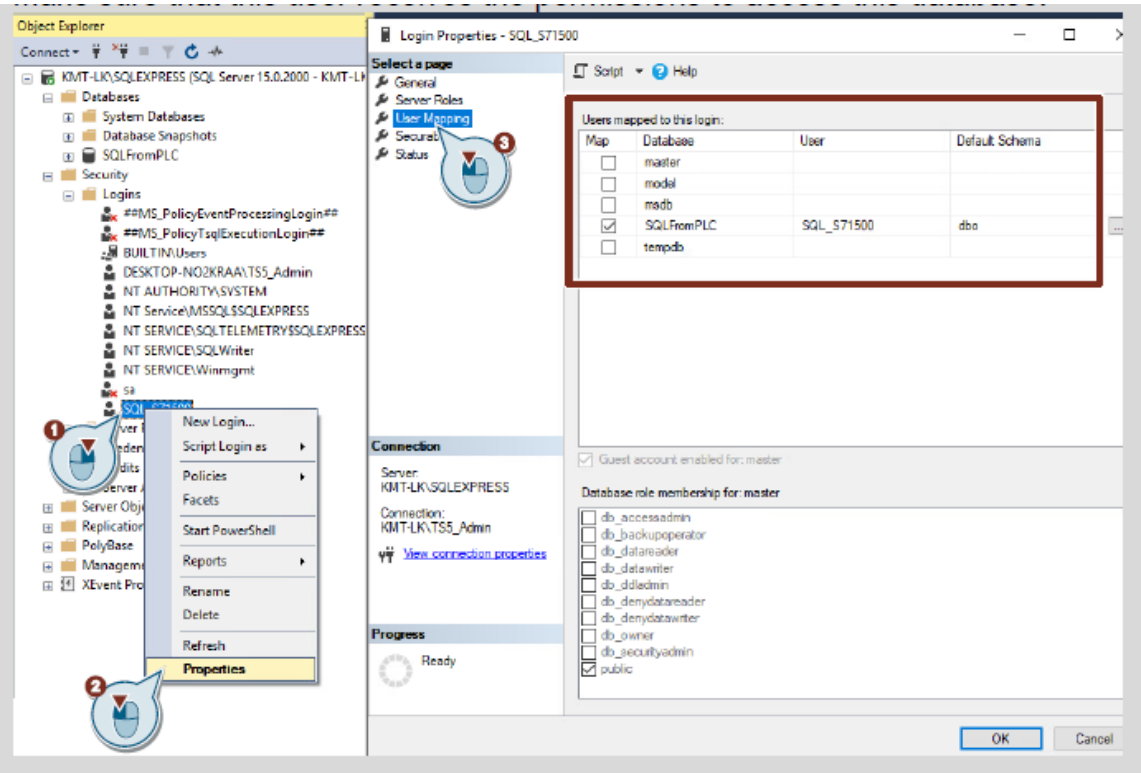
3. In meniul Security activati "SQL Server Authentication Mode" si confirmati modificarile

4. Creati un nou user: Security > Logins > New Login



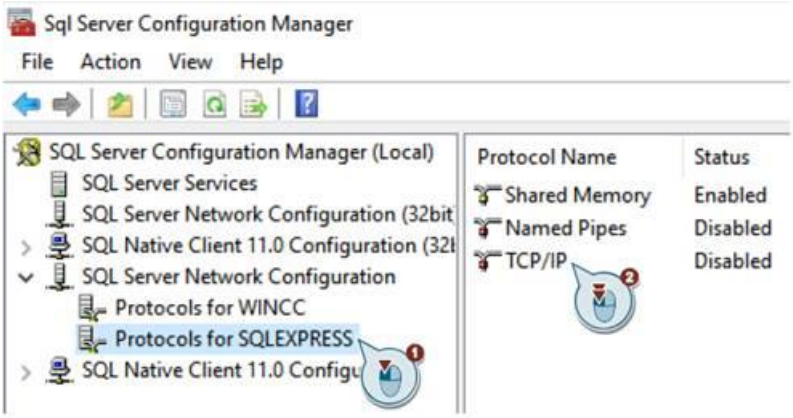
5. Selectati SQL Server authentication si adaugati un user name si o parola

Asigurati-va ca user-ul creat are dreptul de a accesa baza de date



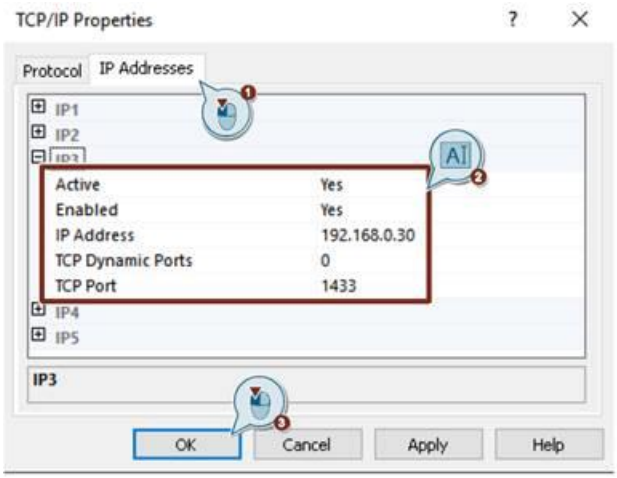
Setarea portului pentru SQL server

1. Se deschide “Microsoft SQL Server Configuration Manager” si se cauta “Protocols for SQLEXPRESS”. Se deschide TCP/IP

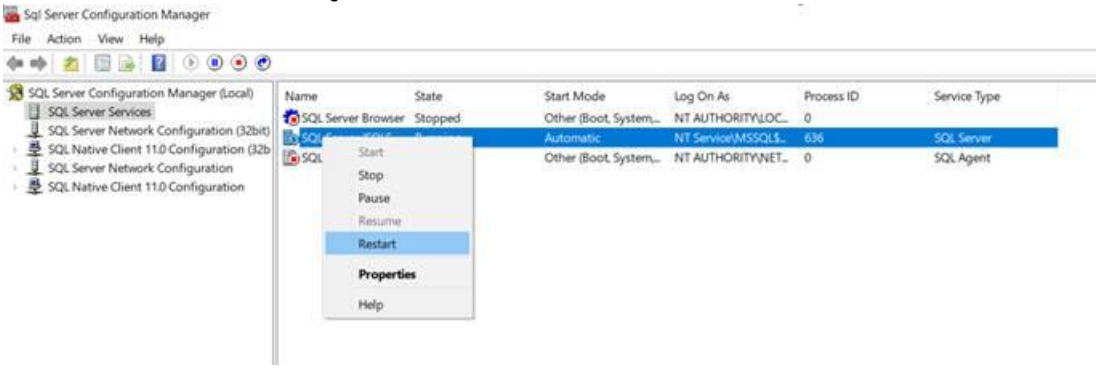


2. Se activeaza TCP/IP

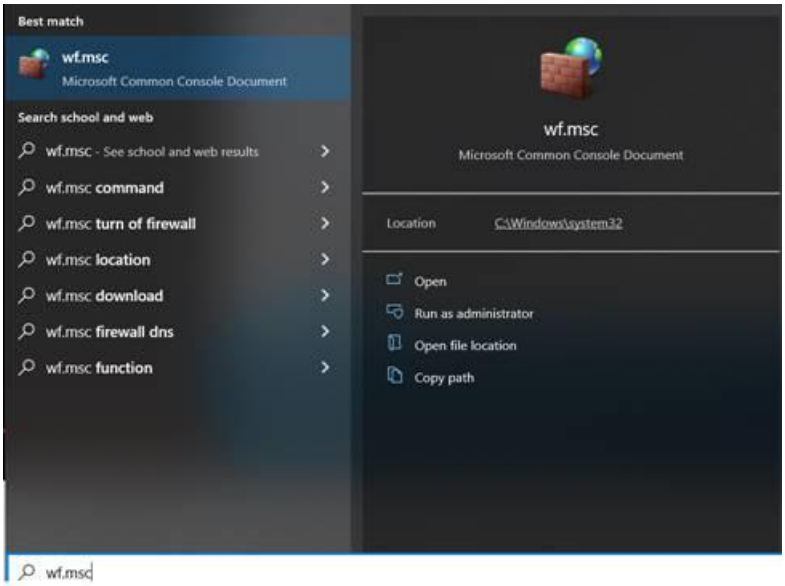
3. Se deschide IP3, se configureaza adresa IP si se seteaza portul 1433. Se activeaza si apasa OK.



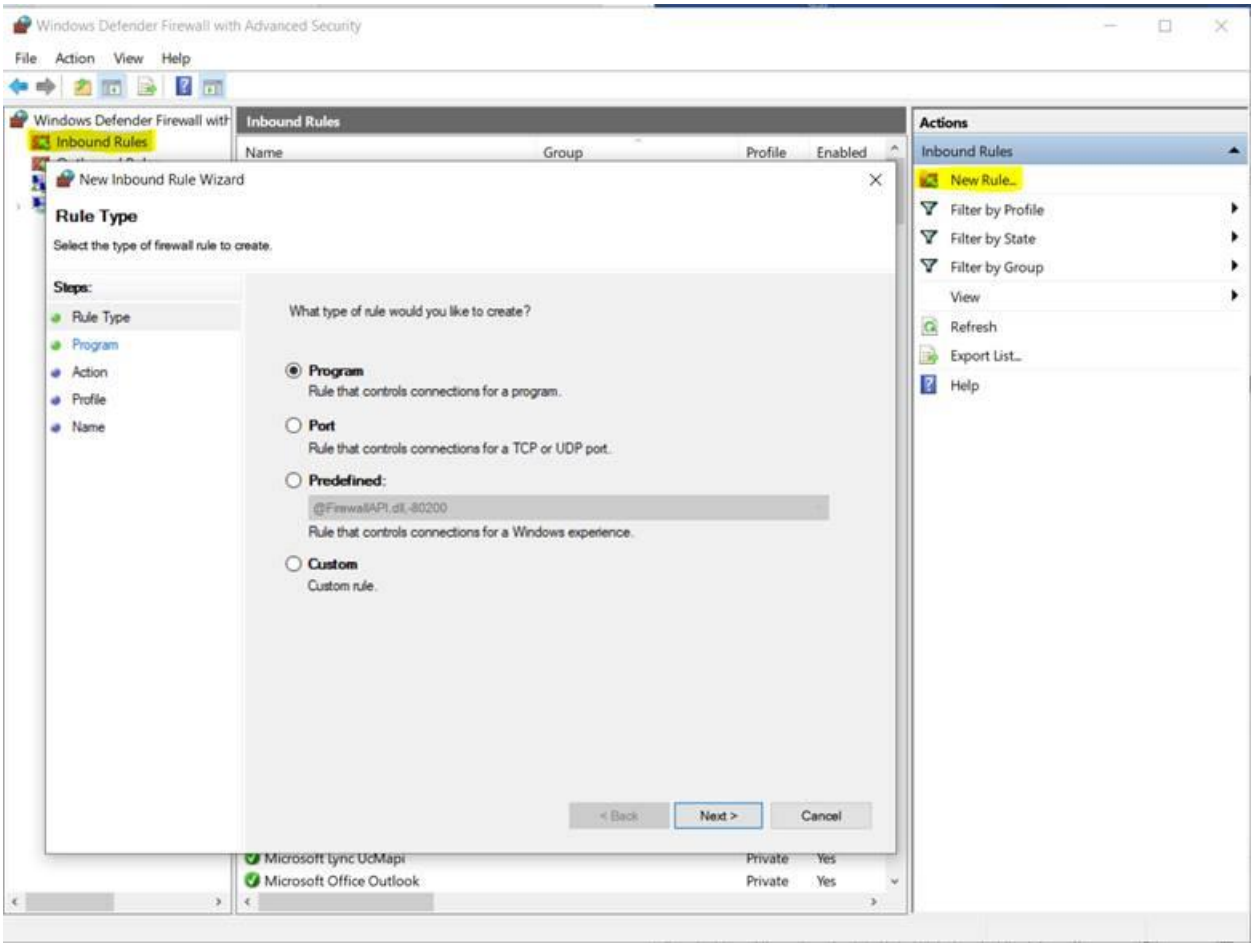
4. Se restarteaza server-ul SQL.



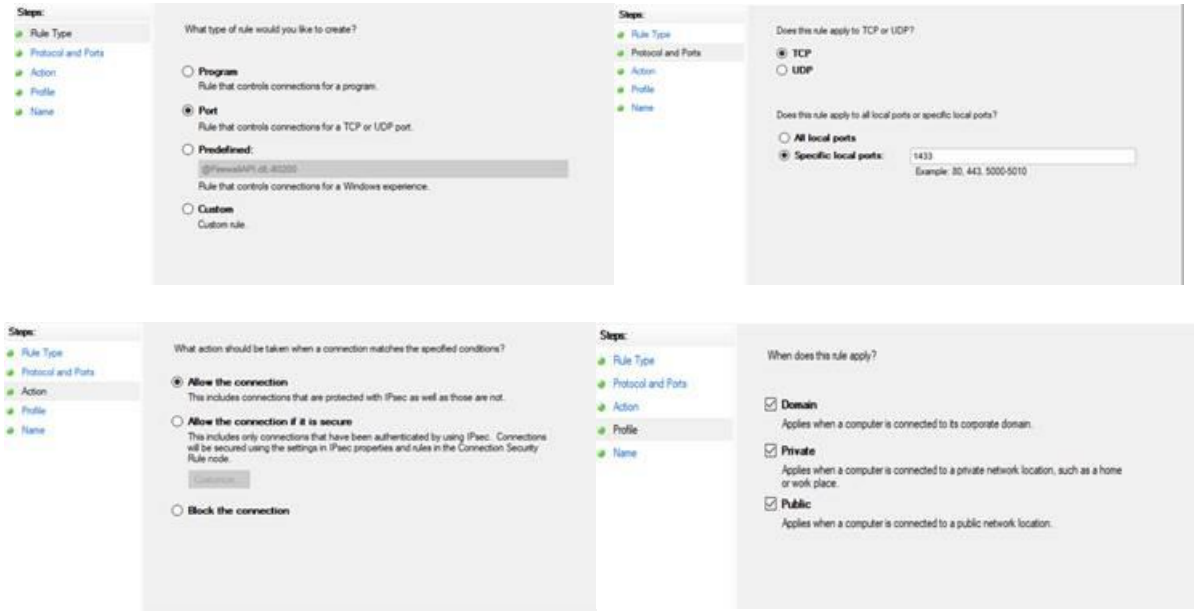
5. Se deschide wf.msc

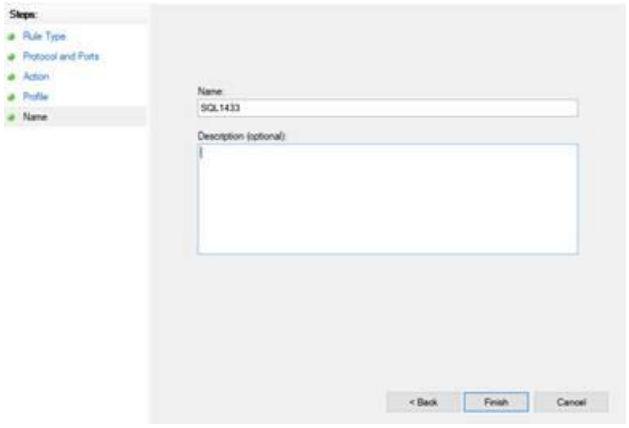


6. Se adauga o noua regula in sectiunea “Inbound Rules” > “New Rule”

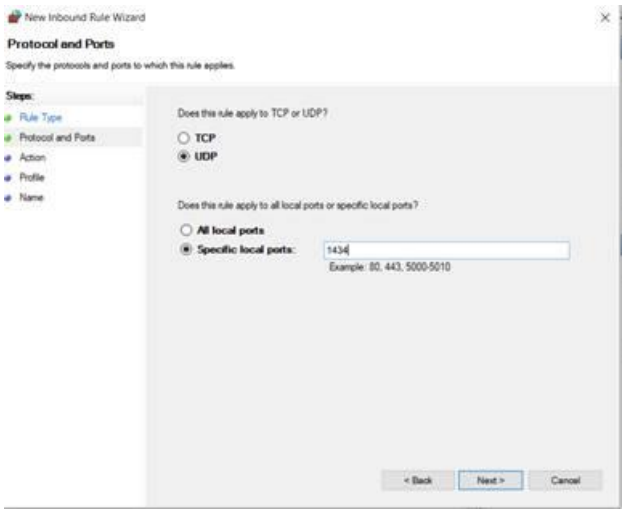


7. Se selecteaza “Port” > “TCP” > “Specific local ports: 1433” > “Allow the connection” > “Domain, Private, Public” > Finish

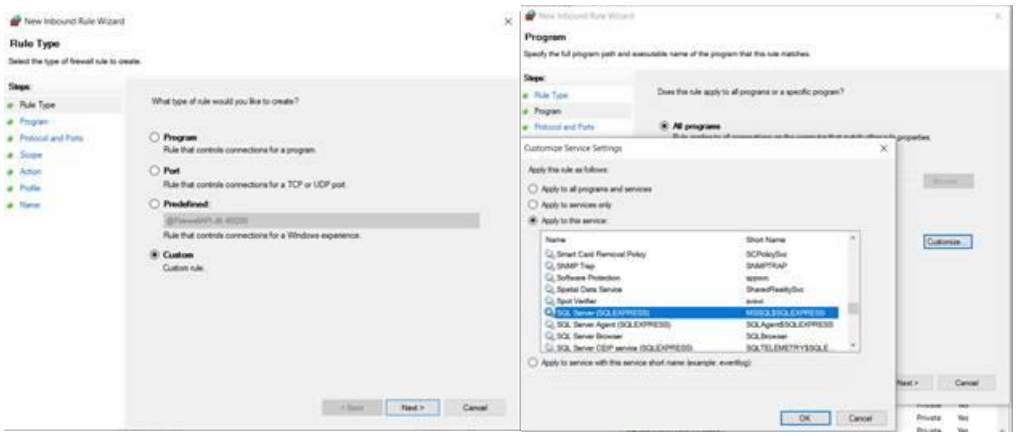




8. Se repeta pasul 7, dar de data aceasta se creeaza o noua regula pentru portul 1434, UDP:



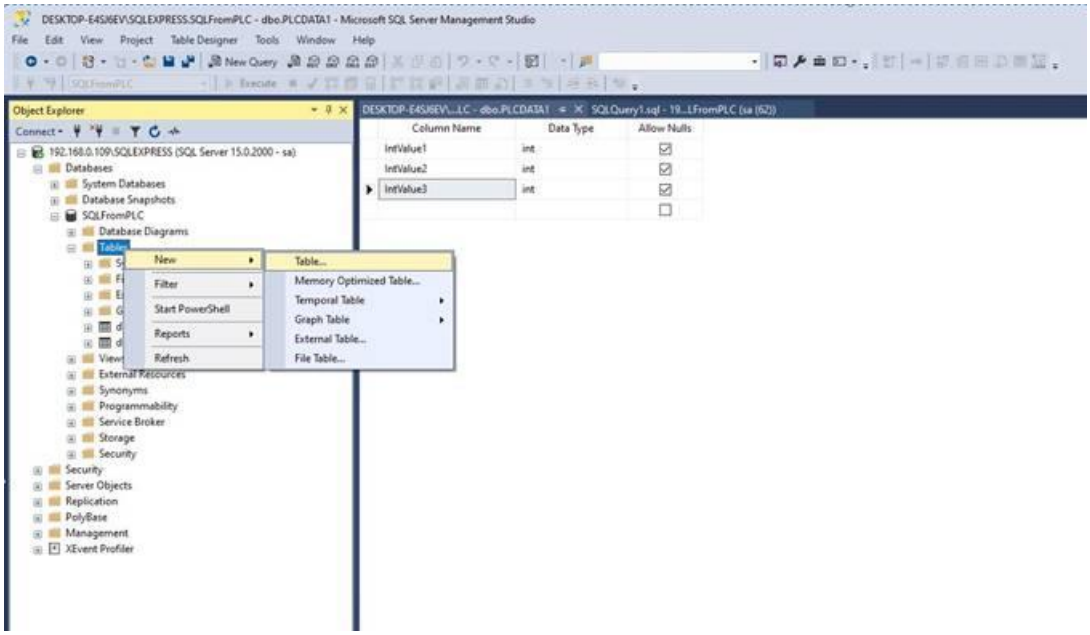
9. Urmatoare regula care trebuie creata este “Custom Rule”, astfel selectam “New Rule” >”Custom rule” > “Customize…” > “Apply to this service” . Se apasa OK si Next pana la final.



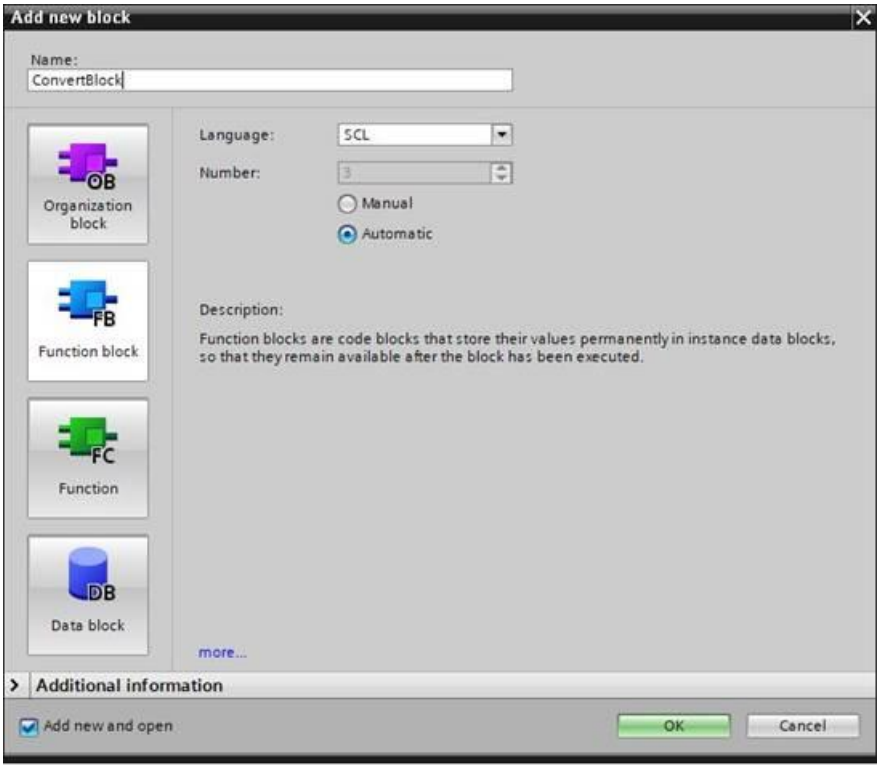
Exemplu aplicatie de scriere in baza de date

Dupa ce s-au realizat pasii descrisi anterior, se deschide Microsoft SQL Server Management Studio si se acceseaza baza de date creata

1. In interiorul bazei de date se creaza un nou tabel de forma celui prezentat in figura urmatoare, cu numele “PLCDATA1”

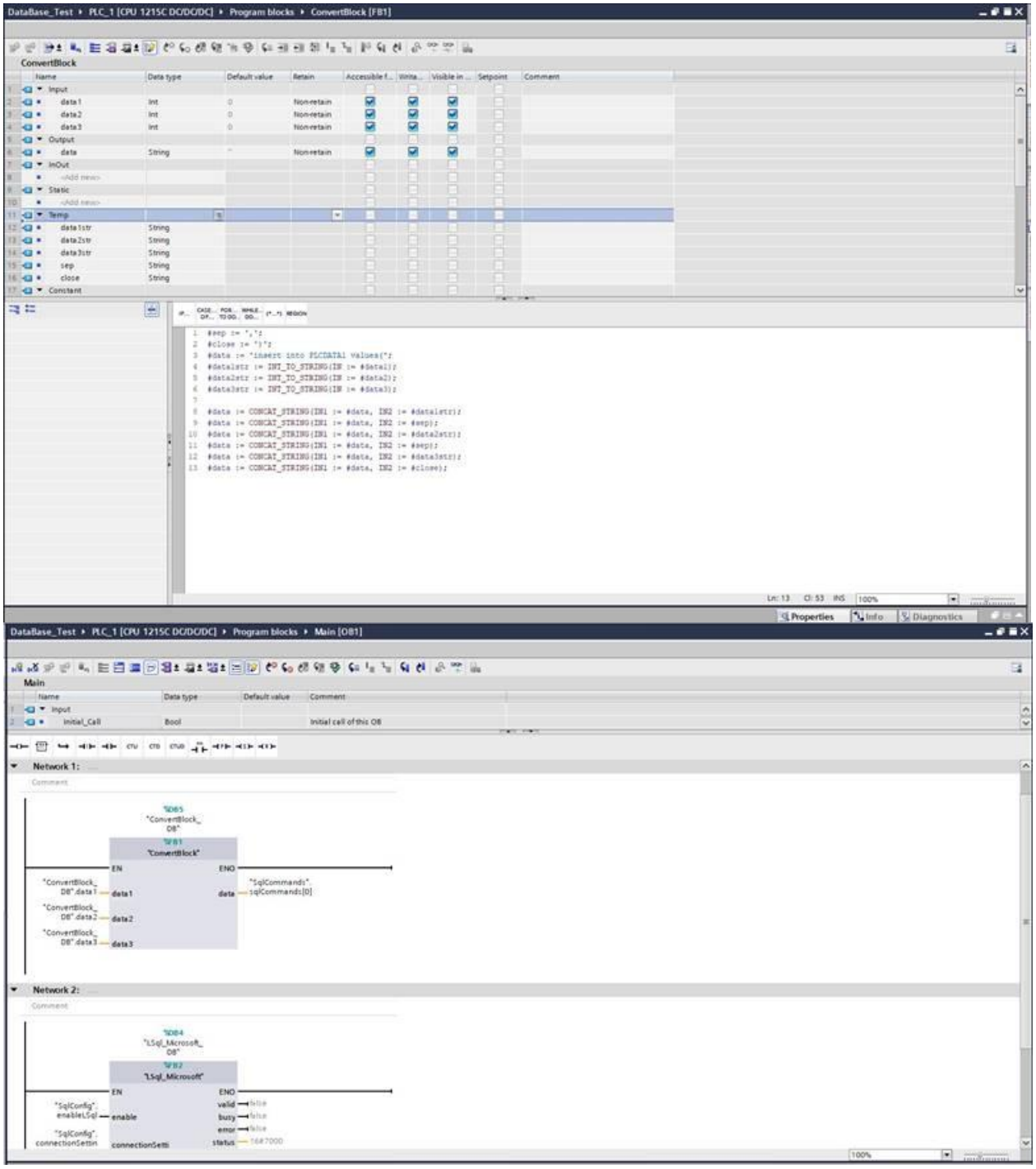
2. 

3. In proiectul creat se adauga un bloc de tip “Function Block” iar ca limbaj se selecteaza SCL

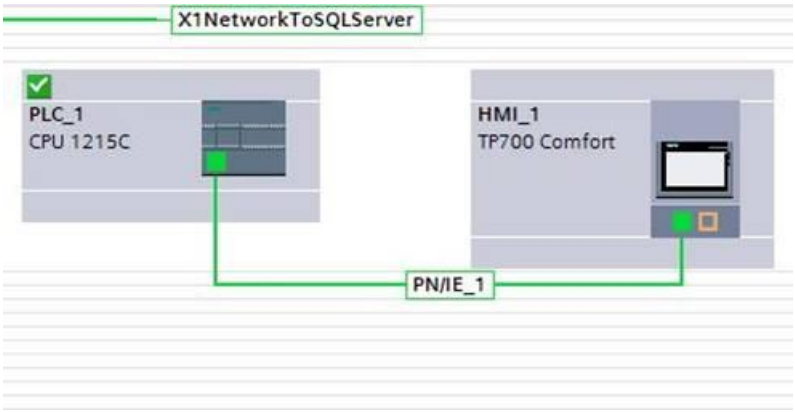


4. Functia se completeaza cu urmatoarele date si se apeleaza in Main

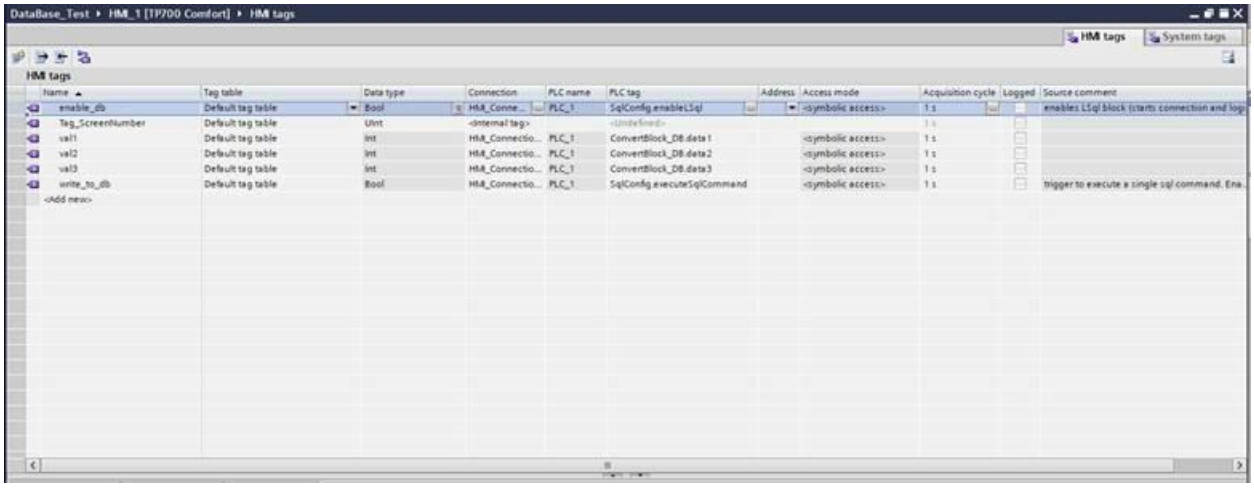
```
#sep := ',';
#close := ')';
#data := 'insert into PLCDATA1 values(';
#data1str := INT_TO_STRING(IN := #data1);
#data2str := INT_TO_STRING(IN := #data2);
#data3str := INT_TO_STRING(IN := #data3);

#data := CONCAT_STRING(IN1 := #data, IN2 := #data1str);
#data := CONCAT_STRING(IN1 := #data, IN2 := #sep);
#data := CONCAT_STRING(IN1 := #data, IN2 := #data2str);
#data := CONCAT_STRING(IN1 := #data, IN2 := #sep);
#data := CONCAT_STRING(IN1 := #data, IN2 := #data3str);
#data := CONCAT_STRING(IN1 := #data, IN2 := #close);
```



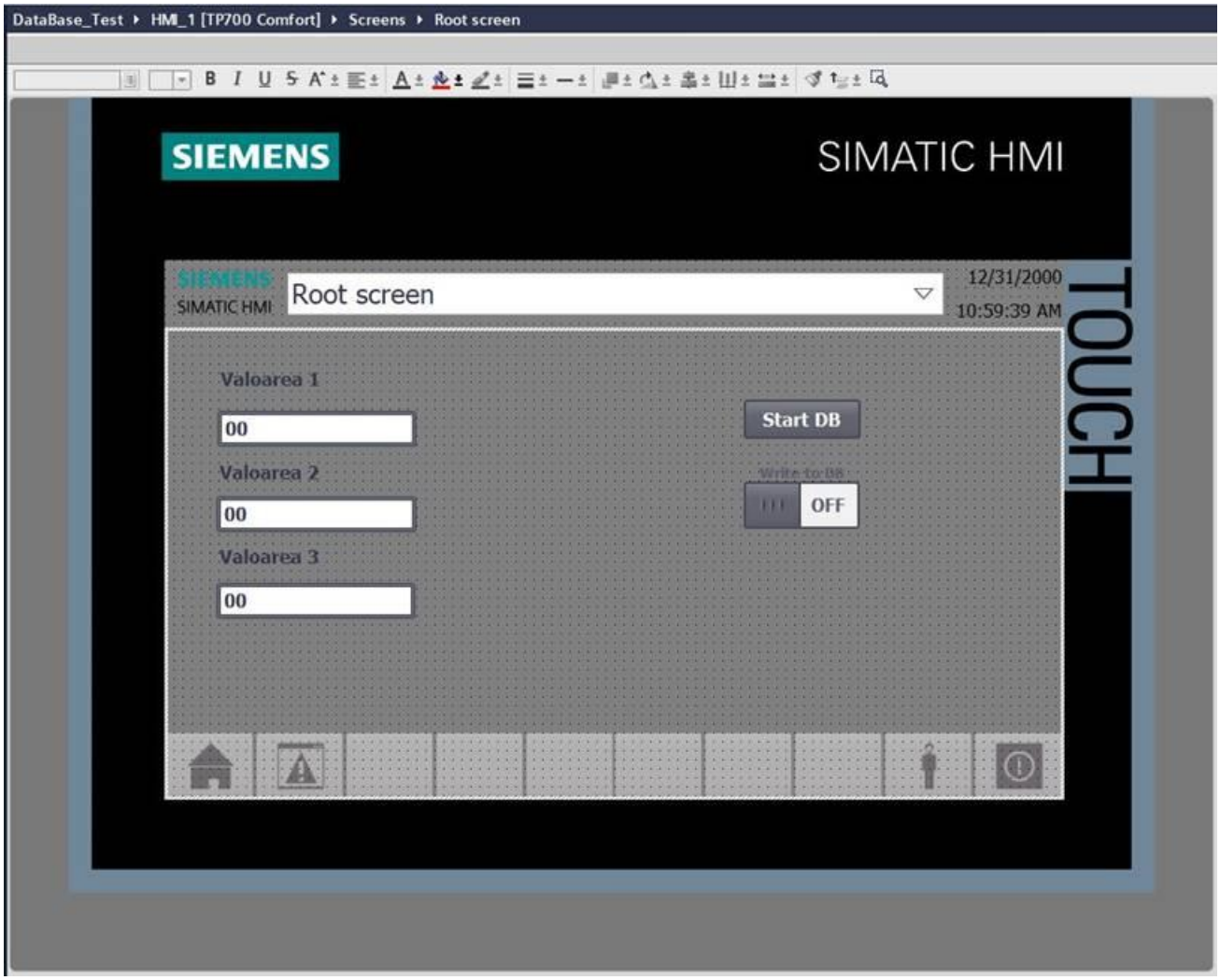
5. Se adauga HMI-ul in proiect si se conecteaza la PLC



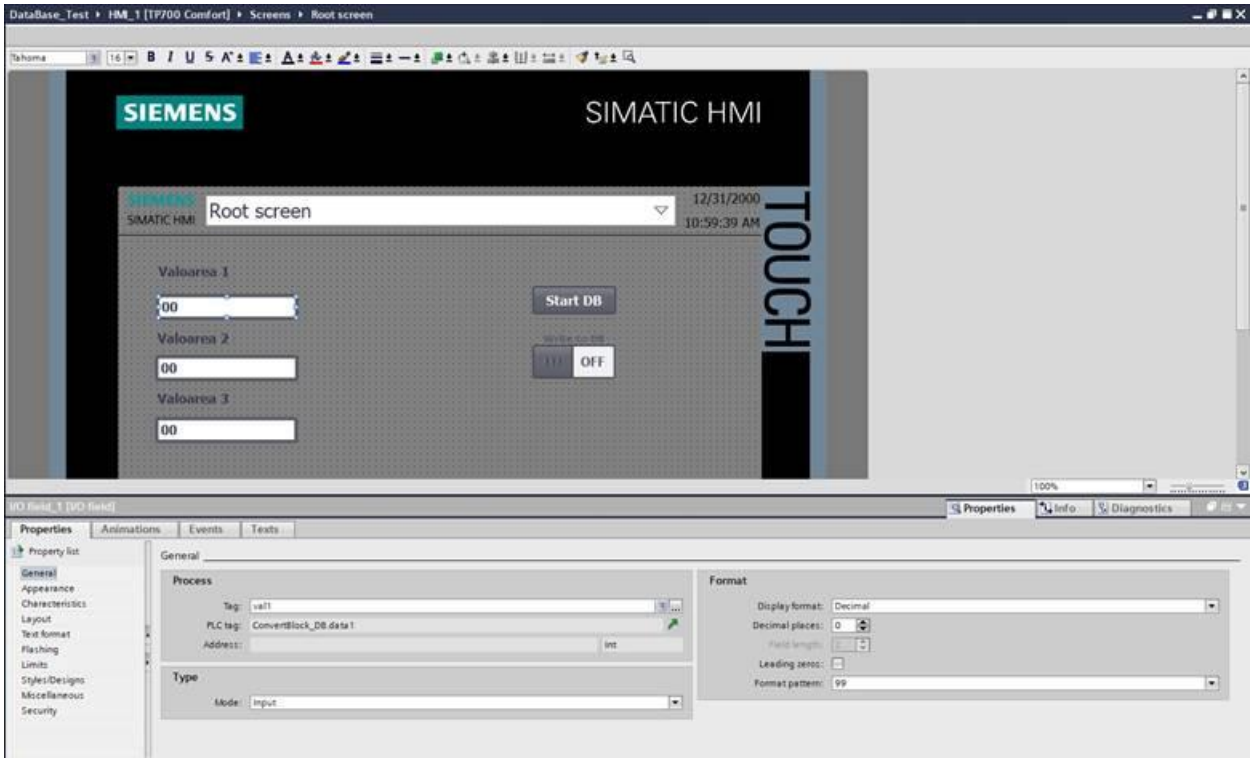
6. Se adauga urmatoarele HMI tags



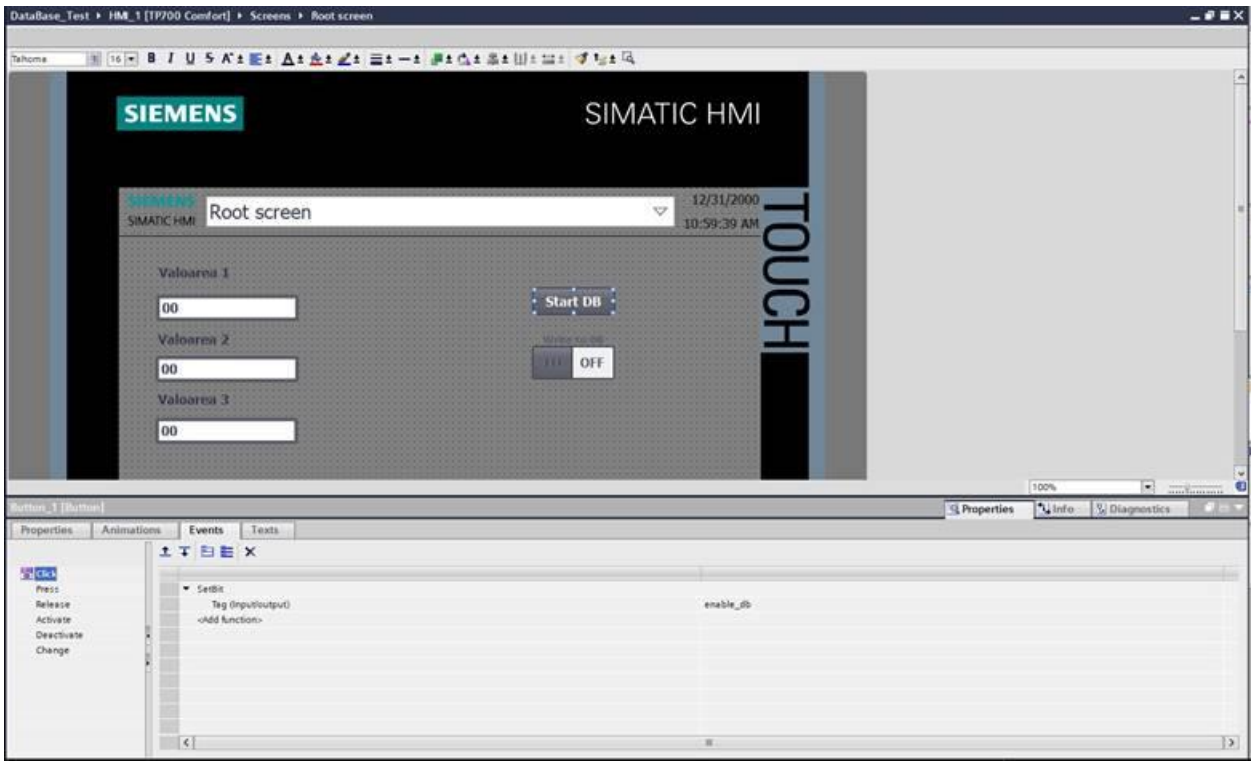
7. In Root Screen de adauga urmatoarele elemente



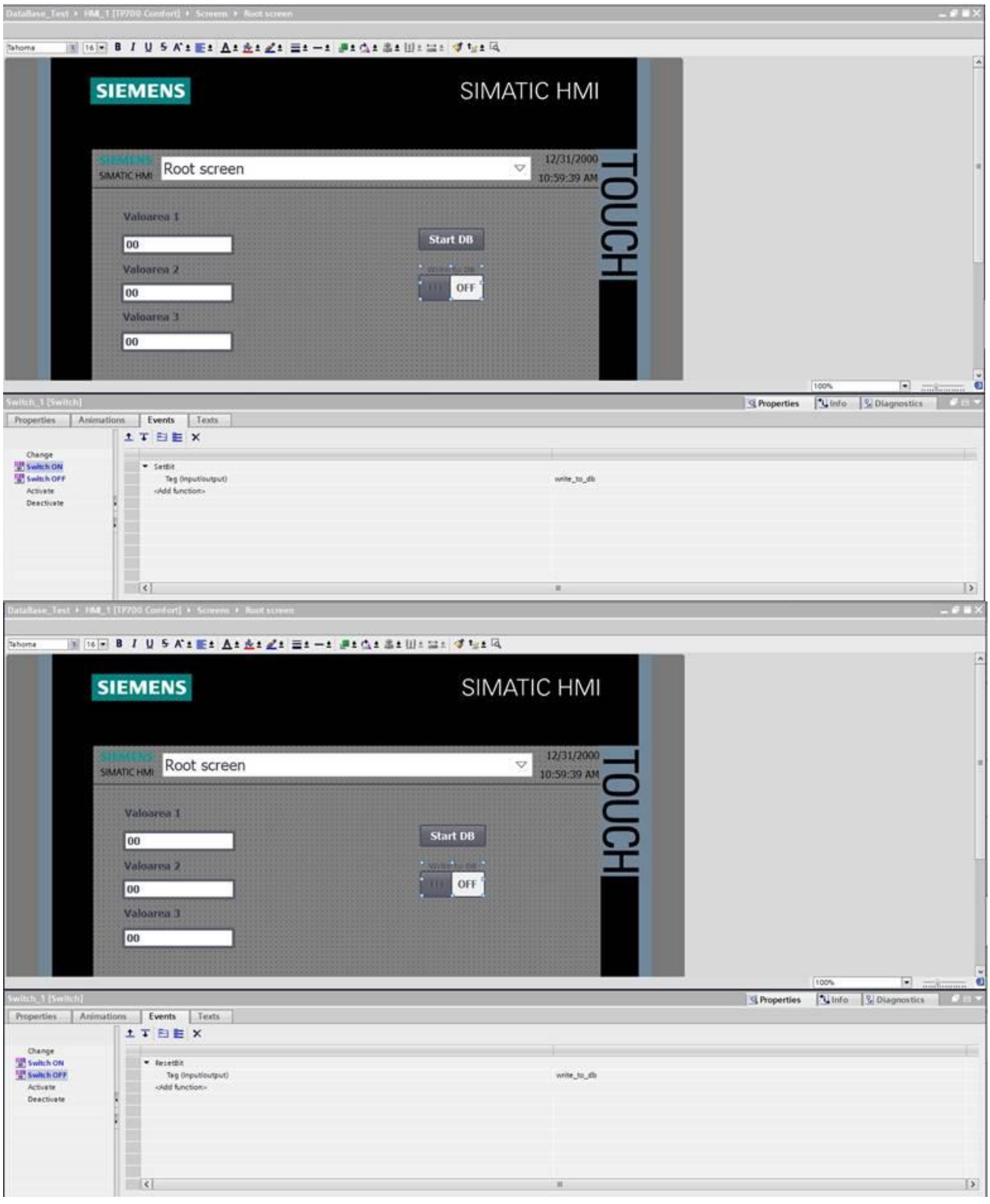
8. Elementele de tip “I/O Field” se conecteaza cu datele de intrare ale functiei create si se modifica tipul elementului > “Input”



9. Pentru butonul de “Start” se adauga un eviniment de tip “Click”, pe care se adauga functia “SetBit” la care ii se atribuie tag-ul “enable_db”. Acest tag se conecteaza cu tag-ul din PLC conform figurii.



10. Pentru switch se adauga pe evenimenul “Switch ON” functia SetBit si ii se atribuie tag-ul write_to_db. Pe evenimentul “Switch OFF” se adauga functia “ResetBit” careia ii se atribuie tag-ul “write_to _db”



11. Se incarca programul creat in PLC si in HMI si se testeaza astfel: se apasa butonul “Start DB” > se inscriu valorile dorite > se comuta switch-ul in pozitia ON > se cauta inregistrarile in baza de date.

Rezumat

- **Web server**
  Formatul comenzii AWP pentru declararea unei variabile:

```
<!-- AWP_In_Variable Name='"Nume_var"' -->
```

Toate variabilele citite din CPU trebuie sa aiba forma:

```
:="Nume_var":
```

- **Rezultate asteptate**
  Dupa studierea acestui modul, ar trebui sa cunoasteti:

  - Cum sa configurati Web_server-ul
  - Cum sa realizati o pagina web HTML in care sa includeti comenzii AWP
  - Sa realizati aplicatii WEB-SCADA

- **Termeni esentiali**

Termen	Descriere
SCADA	Supervisory Control And Data Aquisition

OPC	Open Platform Communications
SQL	Structured Query Language
SCL (Structured Control Language)	Limbaj pentru programarea PLC-urilor de tipul SIMATIC S7-1200/1500

- **Recomandari bibliografice**

- [1] T. Turc - Sisteme SCADA, Ed. Univ. "Petru Maior", ISBN: 978-606-581-110-2 , 2013
- [2] T. Turc - Aplicatii SCADA, Ed. Univ. " Petru Maior", ISBN: 978-606-581-109-6 , 2013
- [3] T. Turc - Programarea microprocesoarelor din familia X86:, Ed. Univ. "Petru Maior", ISBN: 978-606-581-026-6, 2011
- [4] T. Turc - Tehnologii WEB:, Ed. Univ. "Petru Maior", ISBN: 978-973-755-576-2, 2010
- [5] T. Turc - Informatica aplicata in ingineria electrica, ISBN: 978-973-169-700-0, Ed. univ. UMFST, Tg. Mures, 2021.
- [6] T. Turc - Programare avansata C++ pentru ingineria electrica, ISBN: 978-973-755-588-5, Ed. MatrixRom, 2009.
- [7] T. Turc - Elemente de programare C++ utile in ingineria electrica, ISBN: 978-973-755-576-2, Ed. MatrixRom, 2009
- [8] B. Barbat - Informatica industriala - Programarea în timp real – Institutul Central pentru Conducere si informatica 1984
- [9] I. Babuita – Conducerea automata a proceselor – Ed. Facla 1985

- **Link-uri utile**

- https://support.industry.siemens.com/cs/ww/en/view/109755216 - SIMATIC WinCC V15.1 - Programming reference - 2021 -
- https://support.industry.siemens.com/cs/us/en/view/109755202 - STEP 7 and SIMATIC WinCC V15.1 System Manual - 2021 -
- https://support.industry.siemens.com/cs/ww/en/view/81318674 - Programming for SIMATIC S7-1200 and S7-1500 - 2021 -
- https://support.industry.siemens.com/cs/document/39710145 - SIMATIC S7-1200 Easy Book - 2021 -
- https://support.industry.siemens.com/cs/ww/en/view/68011496 - Creating and using user-defined web pages on S7-1200 / S7-1500 -
- S7-1200_1500_Webserver_DOC_v4_en.pdf - Creating user-defined web pages for S7-1200 / S7-1500 - 2021 -
- SQL_S7_1500_DOC_en_V21.pdf - Connecting a S7-1500 to a SQL Database -