pbsSoftLogic

System Manual

Version: 2.0 RC11

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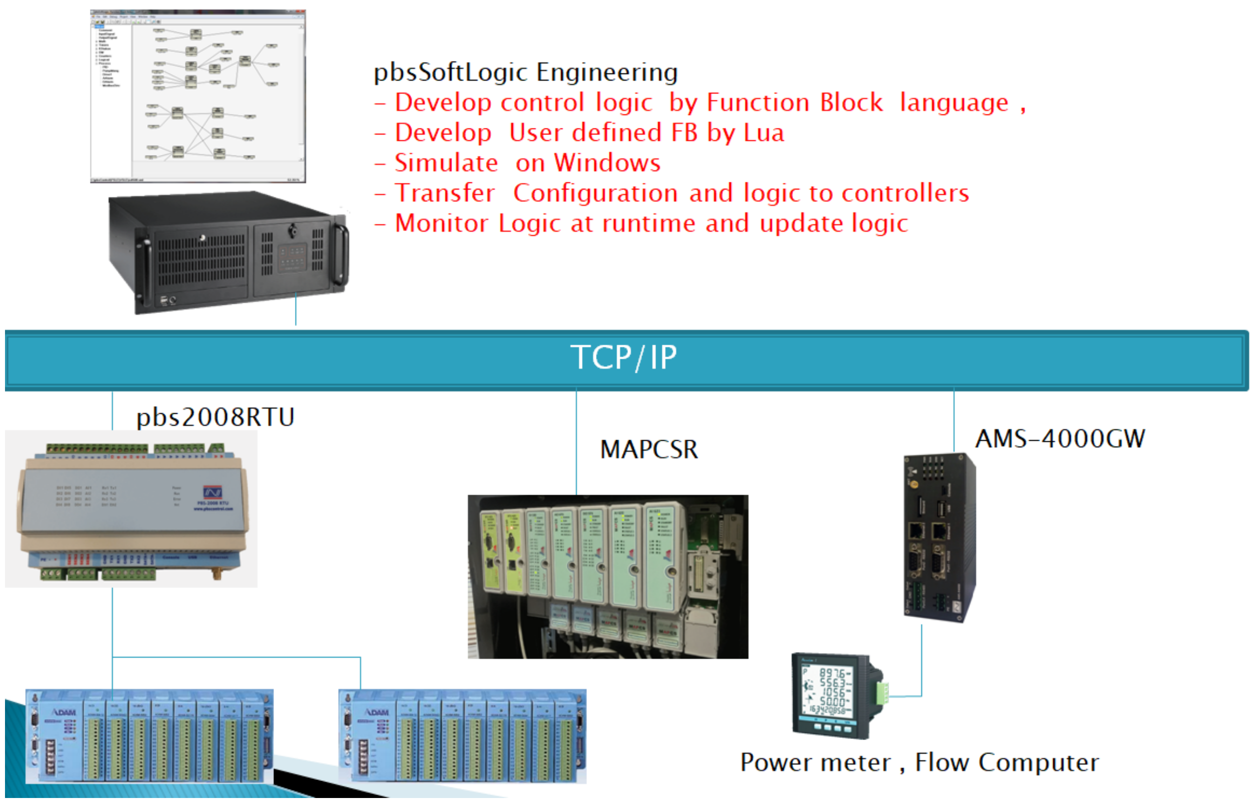
Date: Q3- 2017

1 – Introduction

pbsSoftLogic is open RTU/PLC Programming Environment from pbsControl. pbsSoftlogic is developed by Dot Net technology . pbsSoftLogic development version is running on Windows operating system.

pbsSoftLogic has following specifications :

- Standard Function Block programming Environment
- Lua (scripting Language) is used for user defined Function Blocks development
- Developed application can be run on Embedded Windows , WinCE , QNX and Embedded linux OS
- Offline simulation of developed application on windows
- More than 300 Ready and tested Function block for easy programming.



For update version of pbsSoftLogic please visit www.pbscontrol.com

Current Version: 2.0 RC11

Date: Q3 2017

Supported and tested Hardware:

1- PbsControl PBS2008RTU with embedded Linux OS
2- MAPNA MAPCSR RTU Platform with embedded Linux OS
3- Alborz Micro system ASM-R4000-RTU Modular RTU Platform
4- Alborz Micro System IDL2000 , MDL1000 , RTU100 with embedded Linux
5- Sazgar Sanate Payam(SSP) SGW-3000G ,SGW-3100RTU with embedded Linux OS
6- Advantech ADAM-3600 iRTU , UNO1252G , UNO1110 with embedded Linux
7- MOXA IA240 ,UC7112-Pluse with embedded Linux
8- Any PC based controller with windows 32 OS.
9- Any PC based Controller with WinCE OS .

2 – pbsSoftLogic installation

pbsSoftLogic Engineering is running on following Operating systems :

WindowsXP , Windows Vista , windows7 , Windows Server 2008 and windows Server 2010 .

You need to install Dot Net Frame 4.5.1 on your machine for proper operation of pbsSoftLogic .

You can download latest pbsSoftLogic from http://www.pbscontrol.com

Simply unzip file and run VSFBEditor.exe. No need for any installation process.

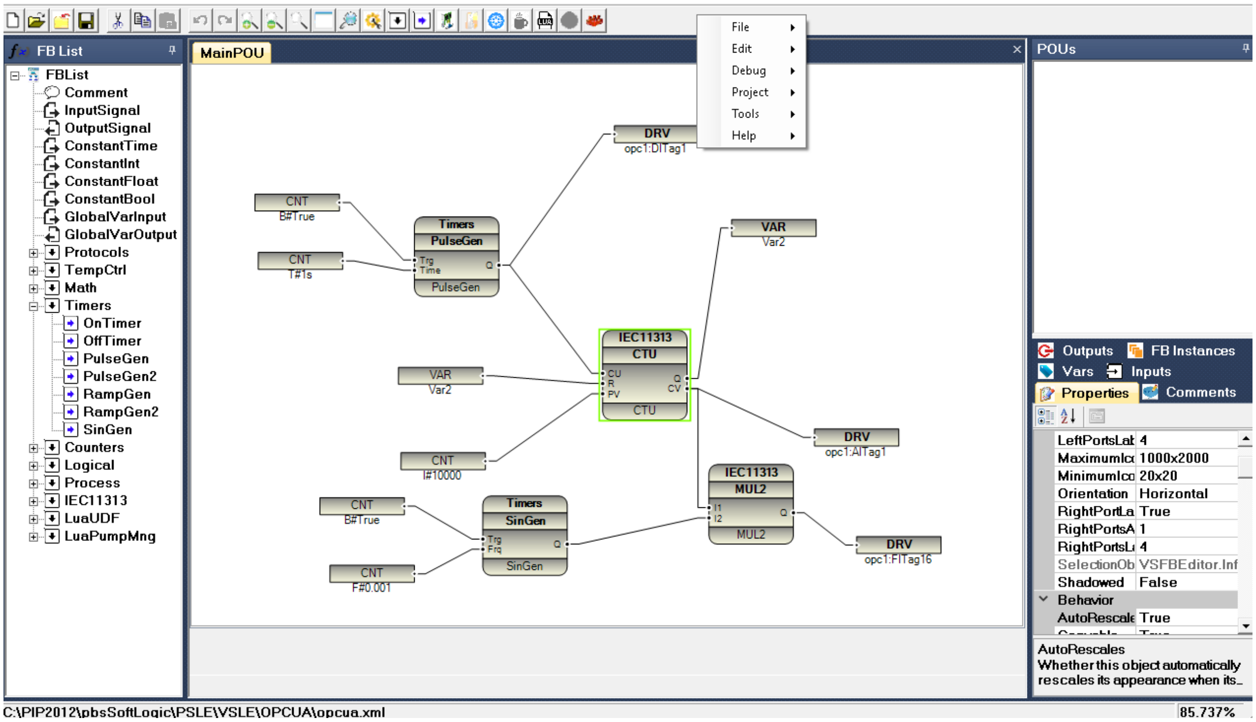
pbssoftLogic files and directories :

- VSFBEditor.exe Main Application for developing Projects .
- FBLuaEditor.exe User defined Function block editor With Lua Scripting language
- OPCExplorer.exe OPC Configuration file for connecting to OPC servers with Windows Target
- pbsLMP.dll Logic Monitoring Protocol . will use for Logic monitoring in Controller .
- options.xml basic options of pbsSoftlogic .
- cfg Directory : Body definition of Function blocks and Lua Source code .
- doc Directory : user manual of pbsSoftlogic
- LinuxCSrc Directory : Source code of C Function blocks
- Timezone Directory: Time Zone file for Linux controller
- VSLE Directory: default developed application with pbsSoftLogic . you can put application and its deriver at any location
- VSLELib Directory : Compiled Lua Script will move in this directory for transferring to controller
- PSLERT Win32 Runtime kernel
- SQLite : SQLite database for local RTU data archiving
- Win32Simulation : Logic simulation kernel
- DNPS.exe , IECSlave.exe , MDL1000.exe , MDL2000.exe , ModbusSlave.exe , SQLiteEditor.exe ,MapCsR1cfg.exe : protocol and Modular RTU Editor . You can use these editors or directly edit xml configuration file for each Modular RTU or protocol.
- Lua52.exe , Luac52.exe Lua Compiler and utility

Other files are system files and should be at PSLE directory .

cfg
de
doc
en
es
fr
License
linux
LinuxCSrc
OPC
openvpn
PSLERT
qnx
ru
Schemes
SDK
Sqlite
target
Temp
Timezone
uk
Utility
VSLE
VSLELib
VSLESrc
Win32simulation
Win32Src
WinCeSrc
DNPS.exe
FBCSEditor.vshost.exe
FBLuaEditor.exe
IECSlave.exe
lua52.exe
luac52.exe
MapCsR1Cfg.exe
MDL1000.exe
ModbusSlave.exe
OPCExplorer.exe
SQLiteEditor.exe
VSFBEditor.exe
VSFBEditor.vshost.exe
VSOPCSimu.exe
Janus.Data.v4.dll
Janus.Windows.CalendarCombo.v4.dll
Janus.Windows.Common.v4.dll
Janus.Windows.FilterEditor.v4.dll
Janus.Windows.GridEX.v4.dll
Janus.Windows.UI.v4.dll
lua51.dll
LuaInterface.dll
Northwoods.Go.dll
Northwoods.Go.Draw.dll
Northwoods.Go.Svg.dll
Northwoods.Go.Xml.dll
pbsLMP.dll
pbsOPCCIAPI.dll
PBSOPCclient.dll
pbsOPCSrvAPI.dll
QWhale.Common.dll
QWhale.Editor.dll
QWhale.Syntax.dll
QWhale.Syntax.Parsers.dll
QWhale.Syntax.Schemes.dll
WtOPCSvr.dll
DNPS.exe.config
FBCSEditor.exe.config
FBCSEditor.vshost.exe.config
FBLuaEditor.exe.config
IECSlave.exe.config
MapCsR1Cfg.exe.config
MapCsR1Cfg.vshost.exe.config
MDL1000.exe.config
ModbusSlave.exe.config
OPCExplorer.exe.config
pbsLogicSimulator.exe.config
SQLiteEditor.exe.config
VSFBEditor.exe.config
VSFBEditor.vshost.exe.config
VSLE.exe.config
VSOPCClient.exe.config
VSOPCSimu.exe.config
VSStartup.exe.config
GlobalSettings.xml
Janus.Windows.CalendarCombo.v4.xml
Janus.Windows.Common.v4.xml
Janus.Windows.FilterEditor.v4.xml
Janus.Windows.GridEX.v4.xml
Janus.Windows.UI.v4.xml
Northwoods.Go.Draw.xml
Northwoods.Go.Svg.xml
Northwoods.Go.xml
Northwoods.Go.Xml.xml
options.xml
QWhale.Common.xml
QWhale.Editor.xml
QWhale.Syntax.Parsers.xml
QWhale.Syntax.Schemes.xml
QWhale.Syntax.xml

In following figure you can see pbsSoftLogic Engineering Environment:



3 – Basic concepts

Writing logic for industrial automation plants and SCADA systems is a critical task. It is not recommended to use low level language like c/c++ and C# for such projects because of following reasons :

1- Not reusable
2- Difficult to transfer project to others and train other engineers for continuing project
3- High risk in application runtime for stability and error free
4- Not future proof
5- Getting Long time for project development

Function Block language is a language for control engineers. They can focus on process logic without

Worry about software part. FB is full graphical language with many tested and ready functions inside.

Using function block language has following benefits:

1 – 100% reusable. There are many tested and ready functions that can be used in different projects with complete document.

2 – It is very easy to train Control and process engineers for using and programming.

3 – pbsSoftLogic is used in many projects and sites in last few years , so there aren't error in the runtime and development environment .

4- You can use pbsSoftLogic and Function block language as framework for whole your Automation Projects. Life time of pbsSoftLogic will be 20 years minimum.

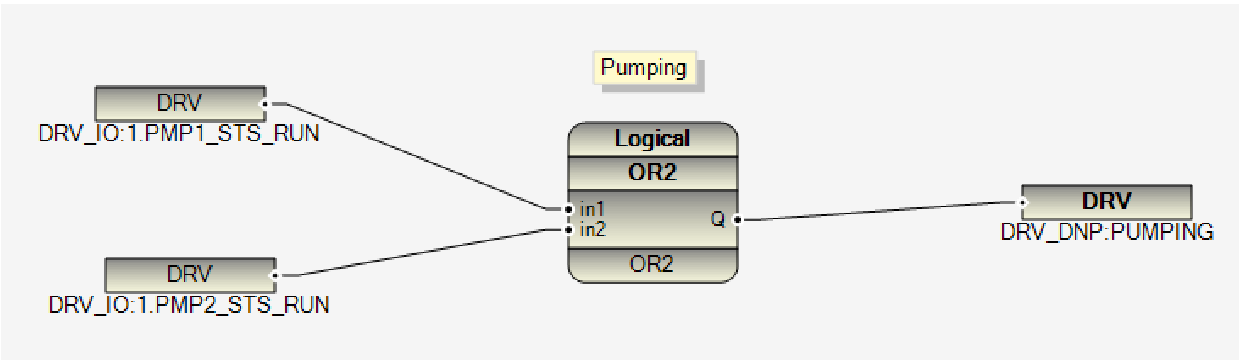
pbssoftLogic is an IDE for developing Function Blocks programs , Simulate , and downloading to Linux /QNX/Win32 based controllers . You can use Lua Scripting language for developing new FB by yourself.

All FB source code of pbsSoftLogic are open source and are located at \psle\LinuxCSrc and \psle\QNXCsrc and \psle\Win32CSrc

4 – Function Block Programming Language

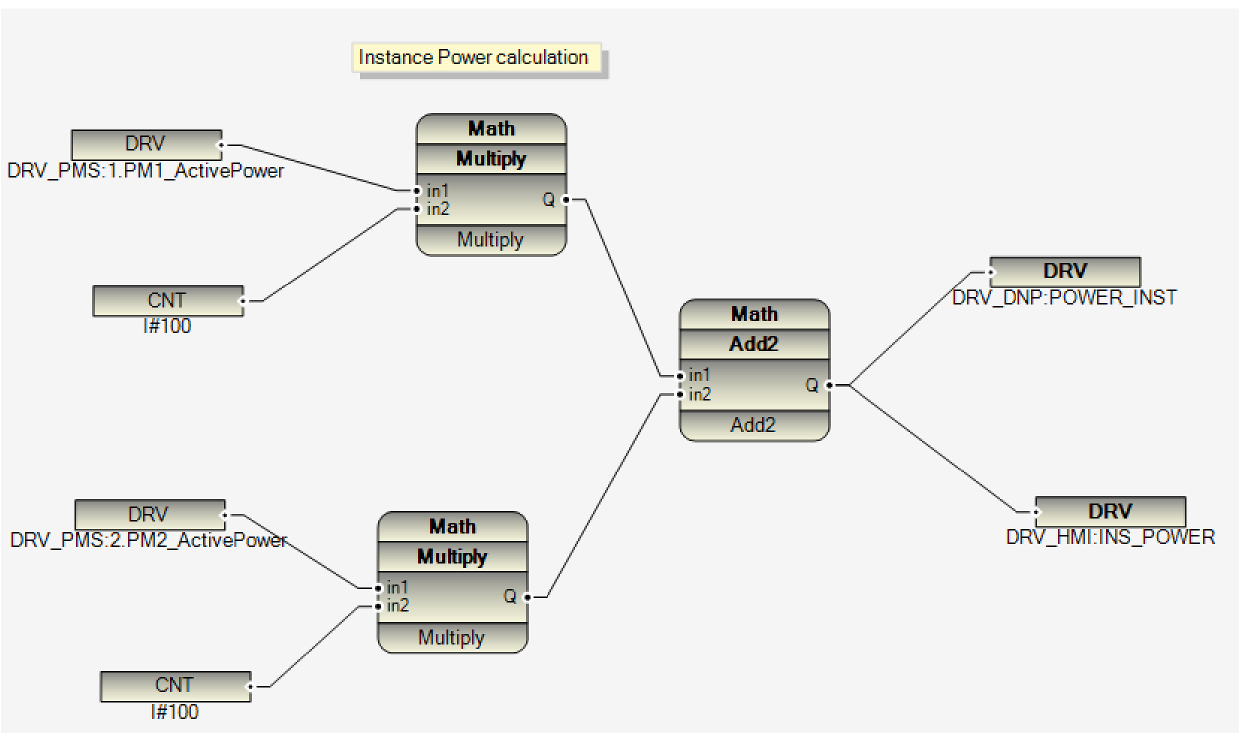
Main element of a Function Block program is FB (Function Block). In Following you can see a few simple examples.

Example1:



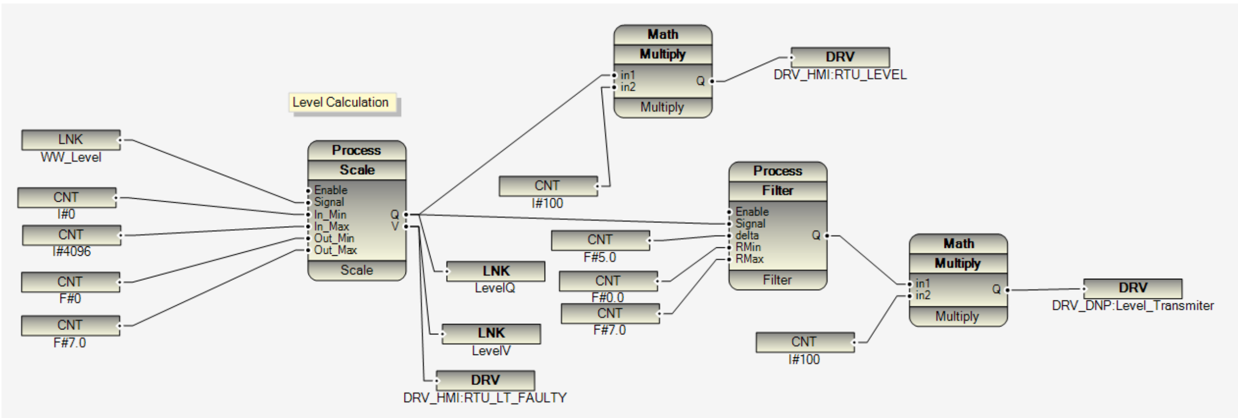
In this logic, two signals PMP1_STS_RUN and PMP2_STS_RUN are input to OR FB and Output will write to PUMPING Signal.

Example 2:



In Example 2 , PM1_ActivePower is multiply by 100 , PMP2_Activepower is multiply by 100 and both results will add together and will write to Power_Instance Signals . (Write on two different sources)

Example 3:



Main Element of a Function Block Program:

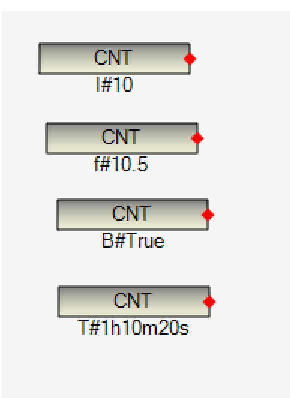
1 – Input /Output Signals: Normally links to Communication Drivers and Local I/O

2 – FB: Ready Function Blocks.

3 – Interconnection between I/O Signals, FBs and between FBs.

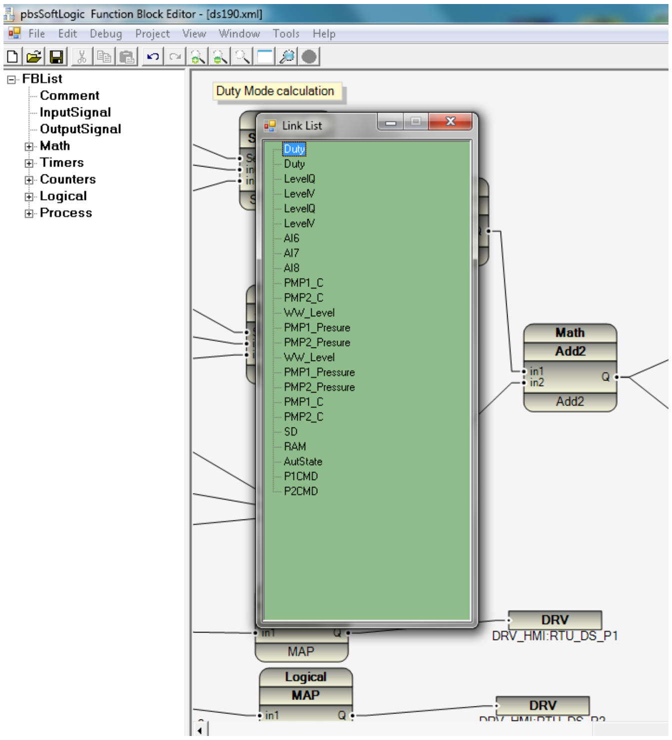
4 – Constant signals: different type of Constant Signals: Integer (I), Float (F), Boolean (B), Time (T)

Constant Signal Format: Type # Value.



5-Internal Link Tags: unlimited internal link tag is possible in logic, but each instance should have different name. Links with same name has same value in logic. LNK and VAR have same usage.

You can see list of all Link Tags in Debug Menu, Link List Item.

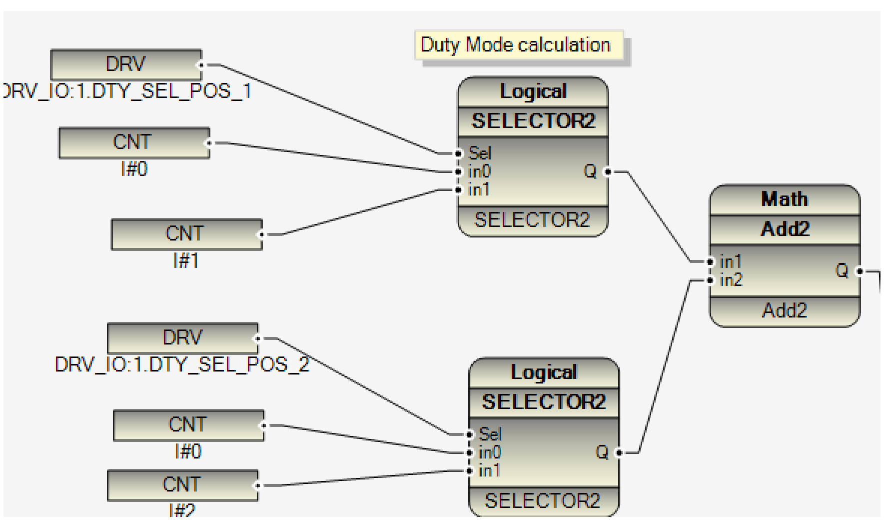


By double click on each link item; Logic will focus on Link/VAR Signal. So you can easily browse and check all link/VAR signals.

LNK/VAR is internal global variable in your project.

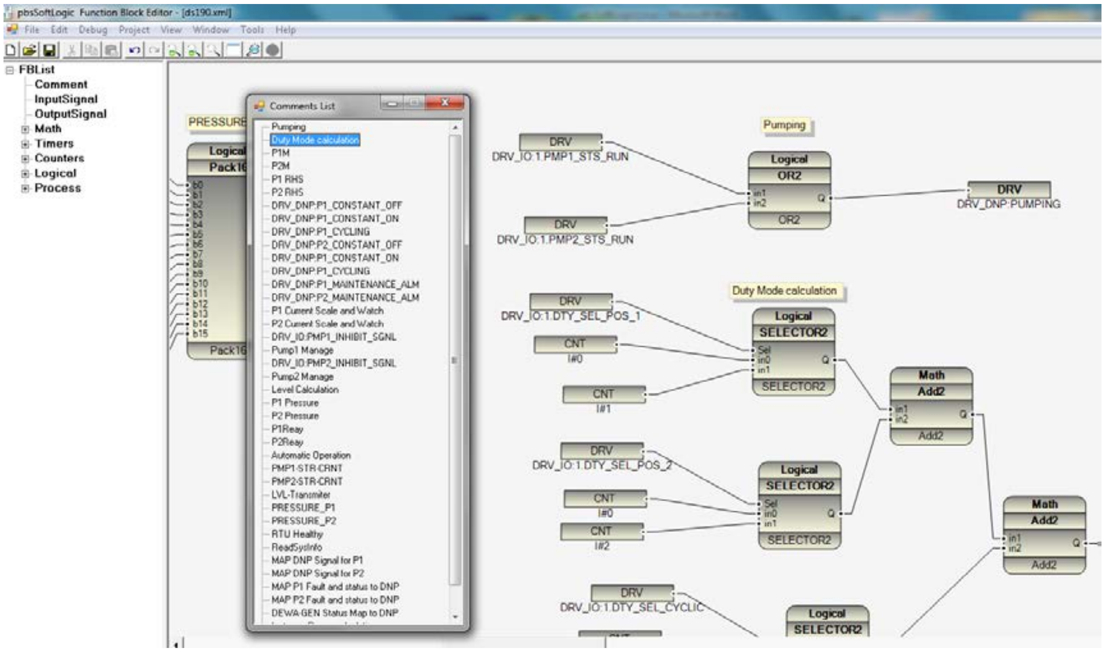
6 – Comments: you can put comment everywhere in logic. Drag a Comment element from FBList and

Drop it in the logic. Then click on Comment and change its content. Comment is like a dynamic size yellow text box.



By selecting comments items from Debug menu, you can see list of all Comments in the logic.

By Double click on any comment, logic will focus there and you can easily browse all logic by comments.



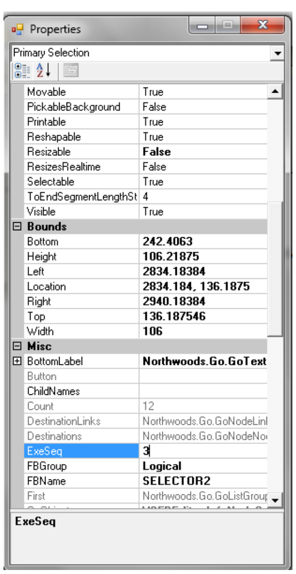
Function Block Programming Rules:

1 – FB Inputs (Left side) always connect to one source. You can connect one source (I/O Signal, Internal Link Tag, and Constant) to different FB Inputs; But Multiple Source to One FB Input is not valid.

2 – FB Outputs (Right Side) can be connecting to different Signals. (Not Constant Signals)

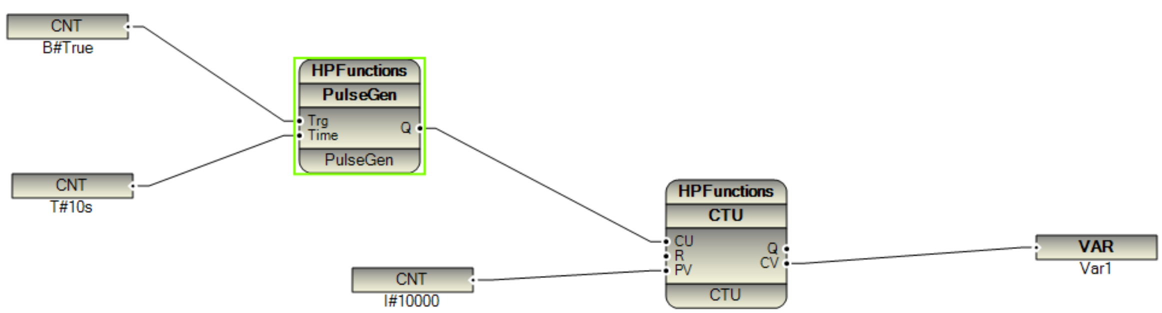
3 – There is no limitation on number of FB interconnections level.

4 – Logic execution: each FB has an Execution number. Click on FB and press F4 , you can see FB properties window . Scroll properties to find ExeSeq .

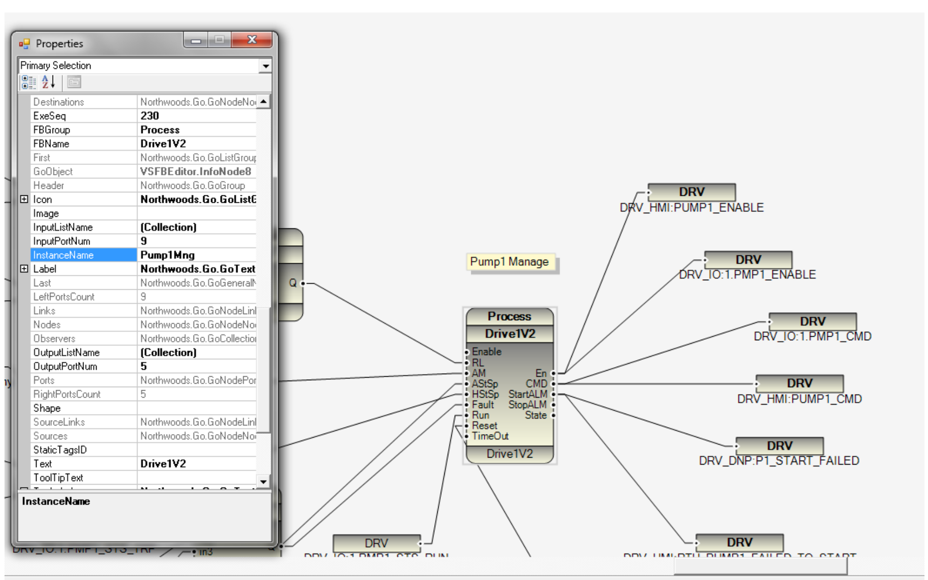


When you start to develop logic , FBEditor will increase ExeSeq number for each FB that you use automatically . but you can change its sequence and by this way , you can control execution sequence of logic . We advise to set all ExeSq numbers manually , because when you copy paste some part of logic , FBEditor will put same values for pasted elements . FBEditor will sort all Fbs by ExeSeq number and compile and make output file by ExeSeq order .

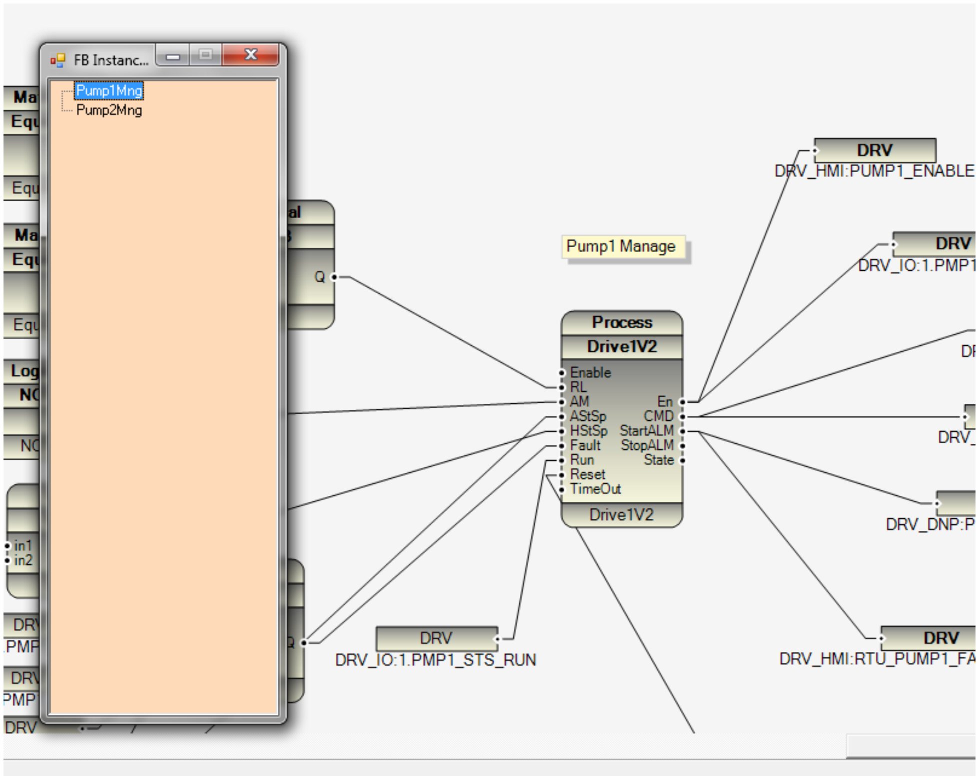
In following sample ExeSeq Number of PulseGen is Bigger than CTU , but Logic will solve without any problem and only in one RTU Cycle there is no output for CTU FB .



5 – Logic FB Instance name : each FB has FBName and instance name . these two properties are equal by default . but you can change Instance name to any unique name in your logic . Suppose you are controlling a Pump by Drive1V2 FB . By changing FB Instancename to “Pump1Mng” , Compiler will use Pump1Mng as identification of FB at compile time . By default it is using PartID property which is always unique in the logic.



You can browse logic by FB Instance name from Debug menu, FB Instance List item. By Double clicking on Instance name, Logic will focus on that part.



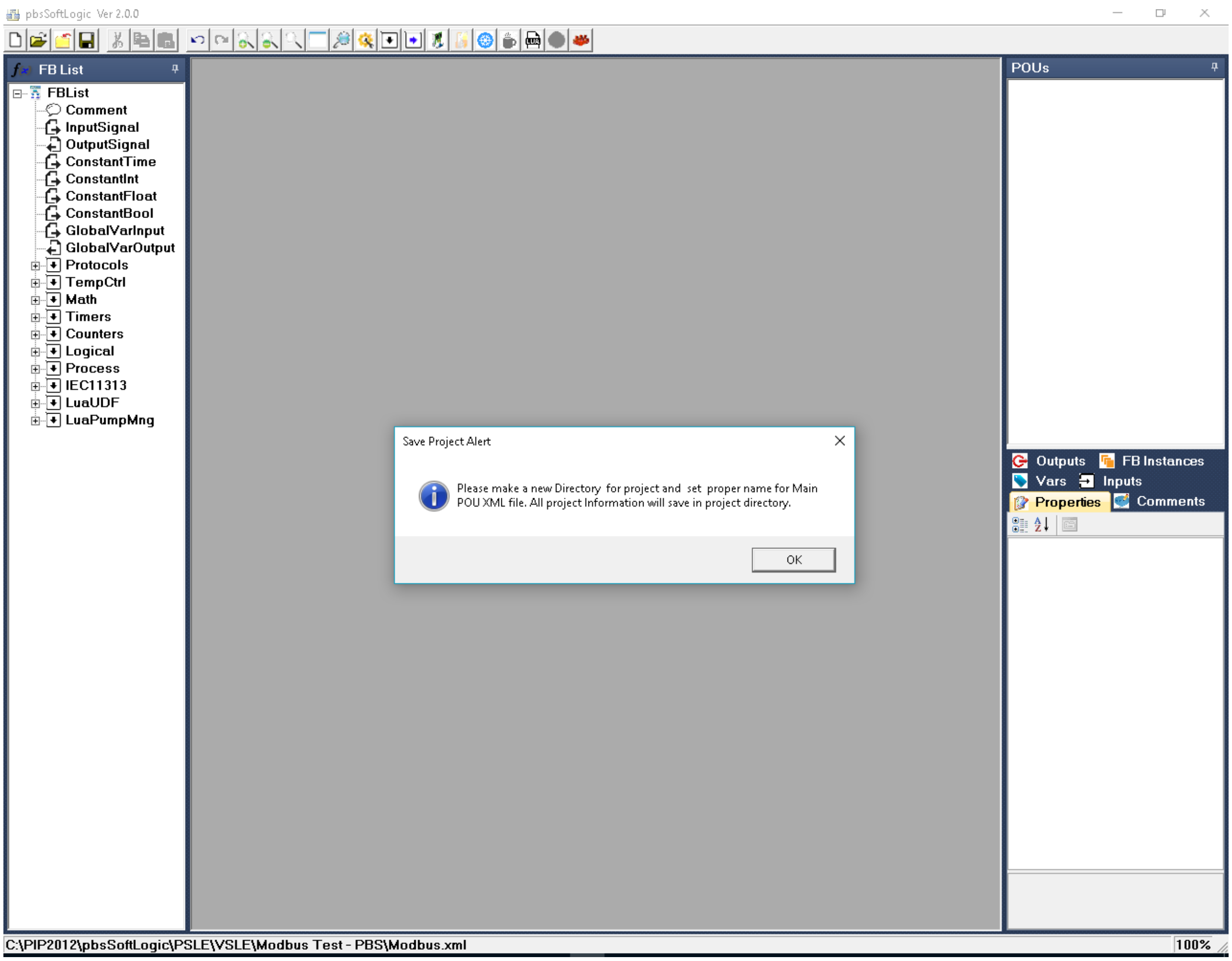
Note : if you want to have 100% warm logic update you should use instance name for critical function blocks .

6 – you can write your logic in multiple Function Block pages . Always First Function Block which is made by PSLE is main POU (Program Organization Block)

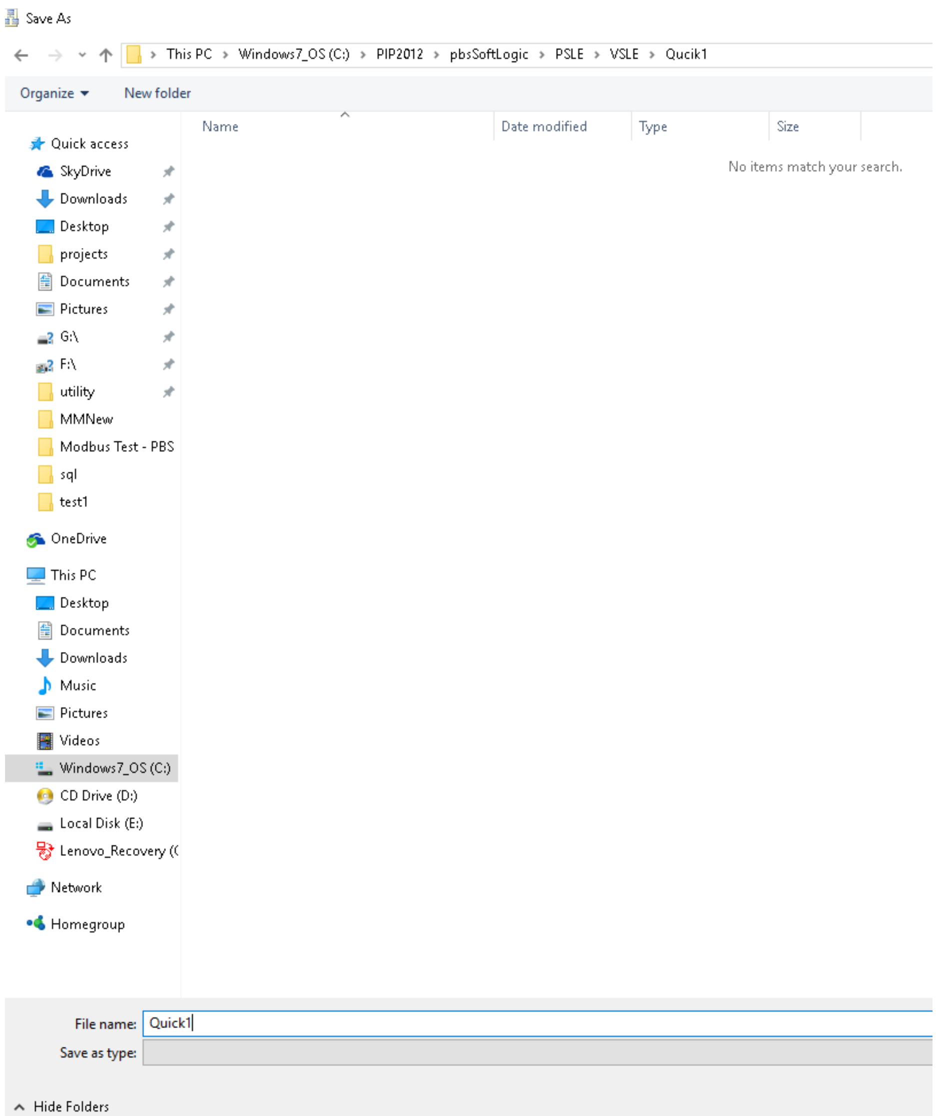
5 – Quick Startup and Logic Simulation

In this part, we will write a simple logic with PSLE and Simulate and run on Linux controller.

Step1: Make a new Application with PSLE. Run VSFBEditor.exe . In File Menu, Select New.

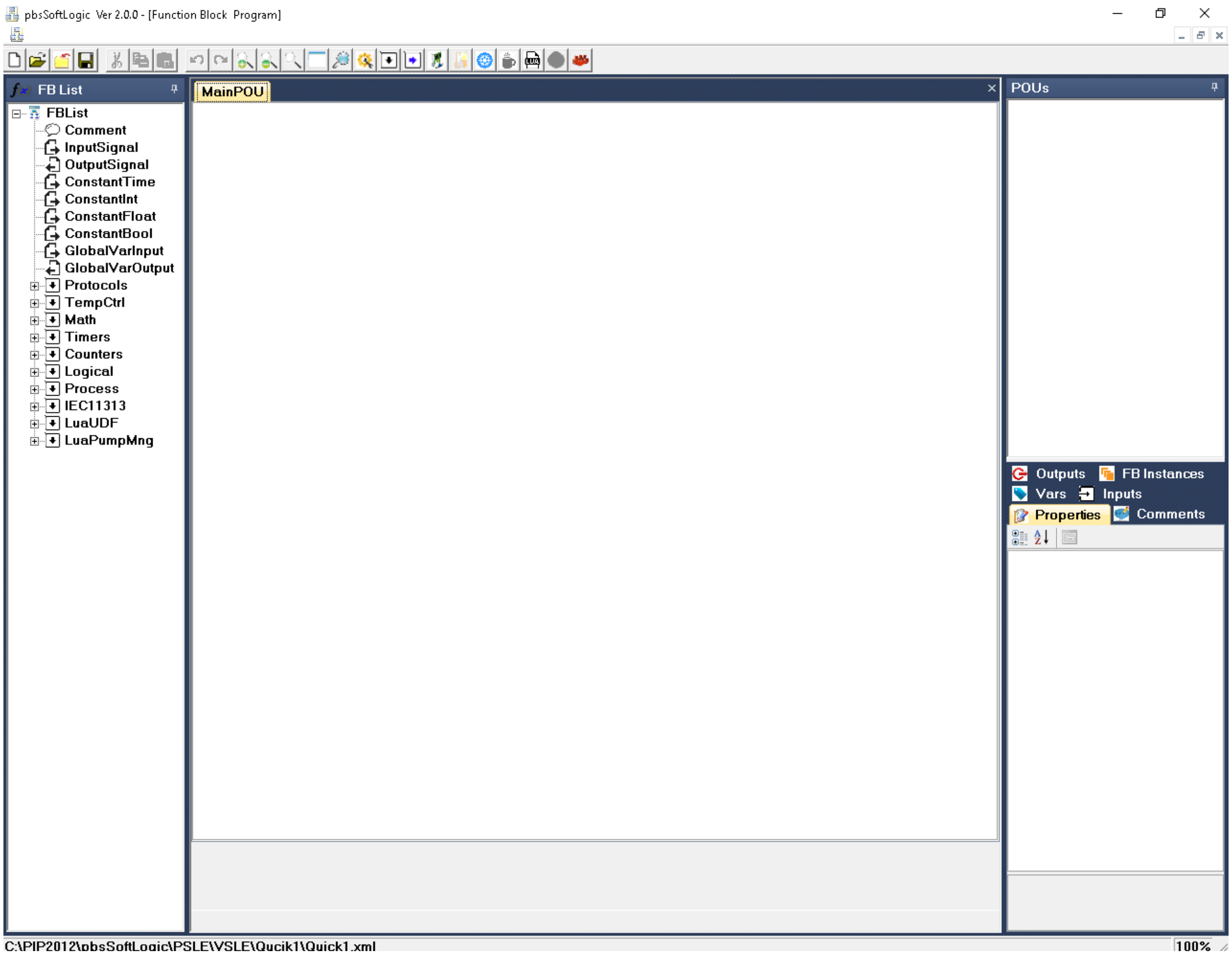


At first step you should make a directory for your project. You can make anywhere in your system with proper name related to your project. Suppose we will make Quick1 Directory in pbsSoftLogic VSLE Path.



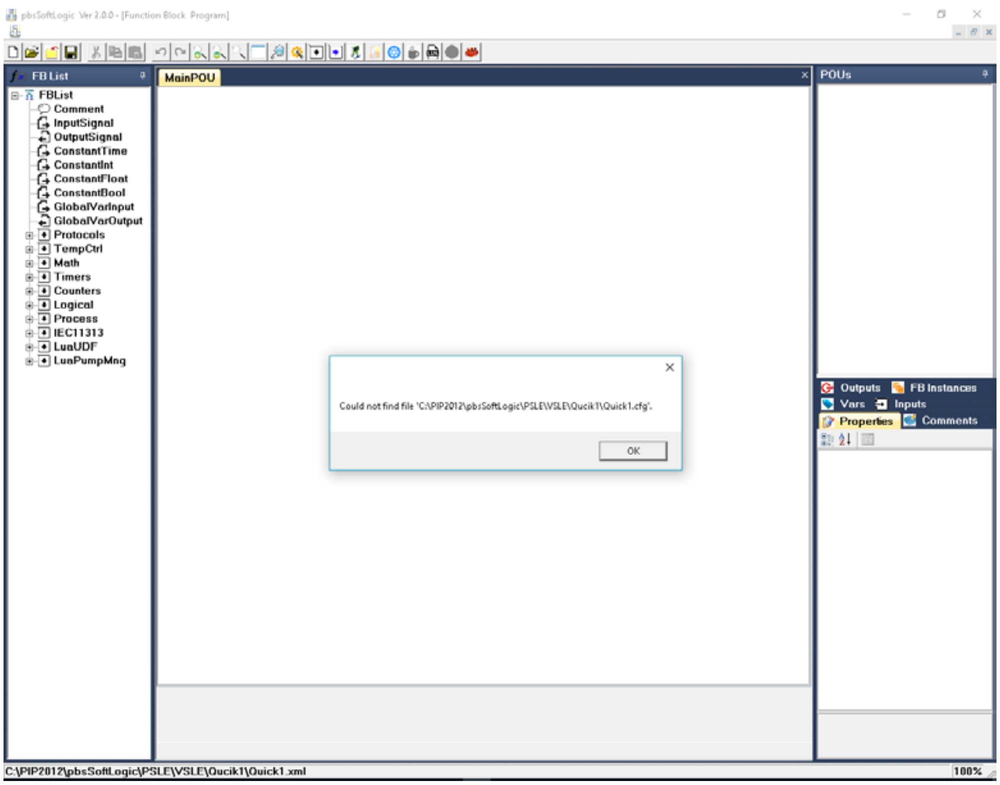
Select a proper name for your MainPOU , I will name MainPOU as Quick1 too .

Click on save button, it will close save form automatically and you are ready for configuration and programming. You couldn't close MainPOU Program and it is always open when your project is open.

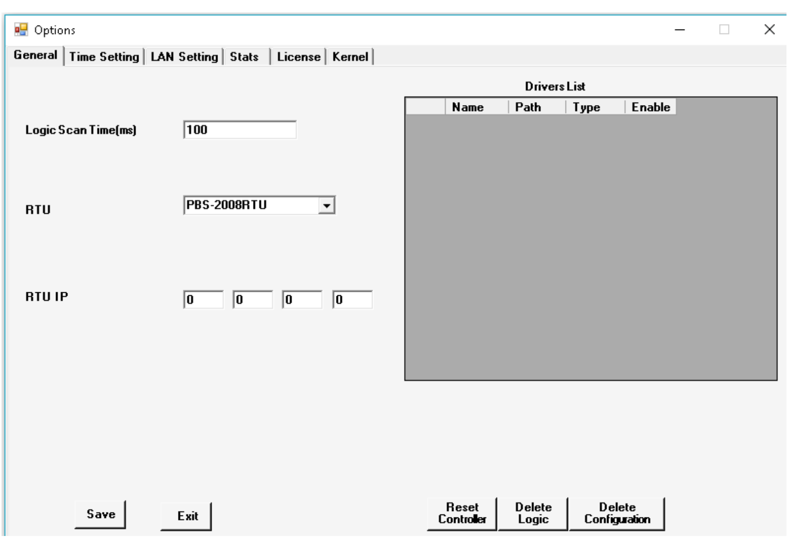

pbsSoftLogic Ver 2.0.0 - [Function Block Program]
FB List
FBList
Comment
InputSignal
OutputSignal
ConstantTime
ConstantInt
ConstantFloat
ConstantBool
GlobalVarInput
GlobalVarOutput
Protocols
TempCtrl
Math
Timers
Counters
Logical
Process
IEC11313
LuaUDF
LuaPumpMng
MainPOU
POUs
Outputs
FB Instances
Vars
Inputs
Properties
Comments
C:\PIP2012\pbsSoftLogic\PSLE\VSLE\Qucik1\Quick1.xml
100%

Step2 : Select your RTU Type . Click on project setting button

pbsSoftLogic will prompt you that there is no any configuration file for this project . Simply Click on OK Button to open project setting page.



When Project setting page is opened, it will show by default pbs2008RTU as controller.



Open RTU Combo Box you can see different RTU that is supported by pbsSoftLogic . For now use same pbs2008RTU.

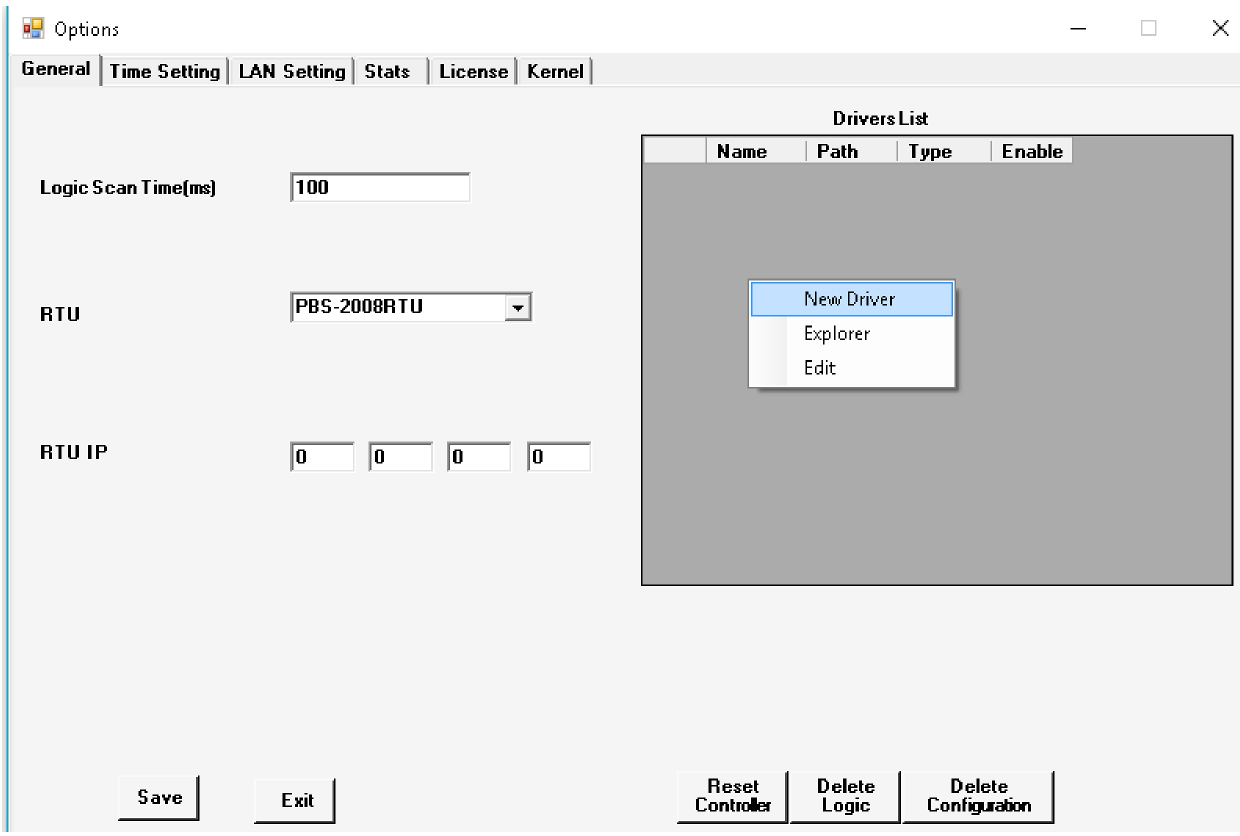
Type RTU IP for example type 192.168.1.213

Keep Logic Scan Time as 100msec . This is loop time for reading All Driver Inputs, Solve Logic and write Driver Outputs. Every 100 msec above sequence will, but may be whole this sequence only get 2 msec to finish and 98 msec CPU is sleeping .

Click on save button to save configuration.

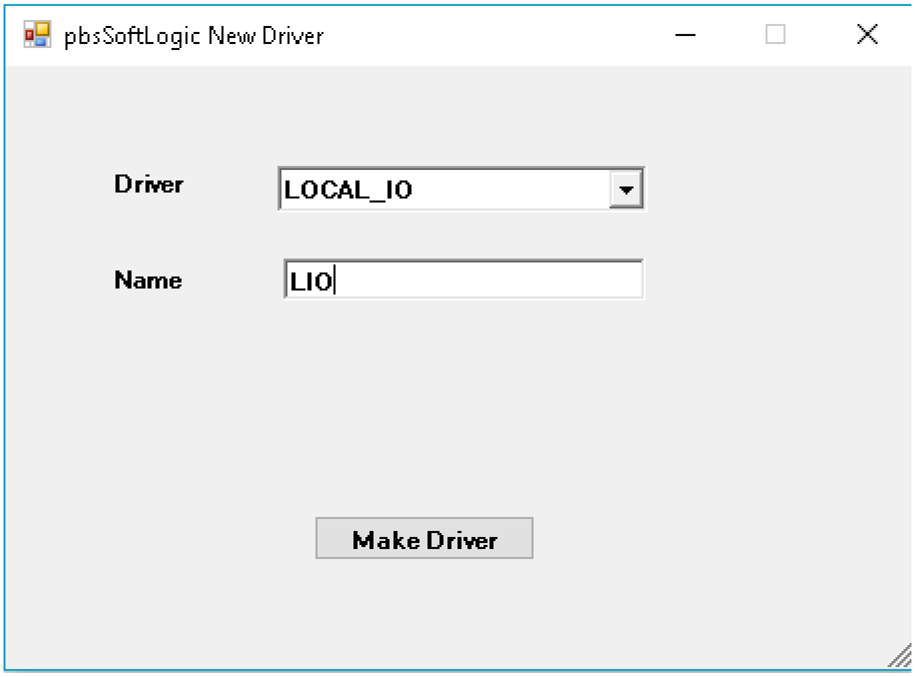
Step3 : Define Local IO for RTU

Right click In Driver List part and select New Driver Command :

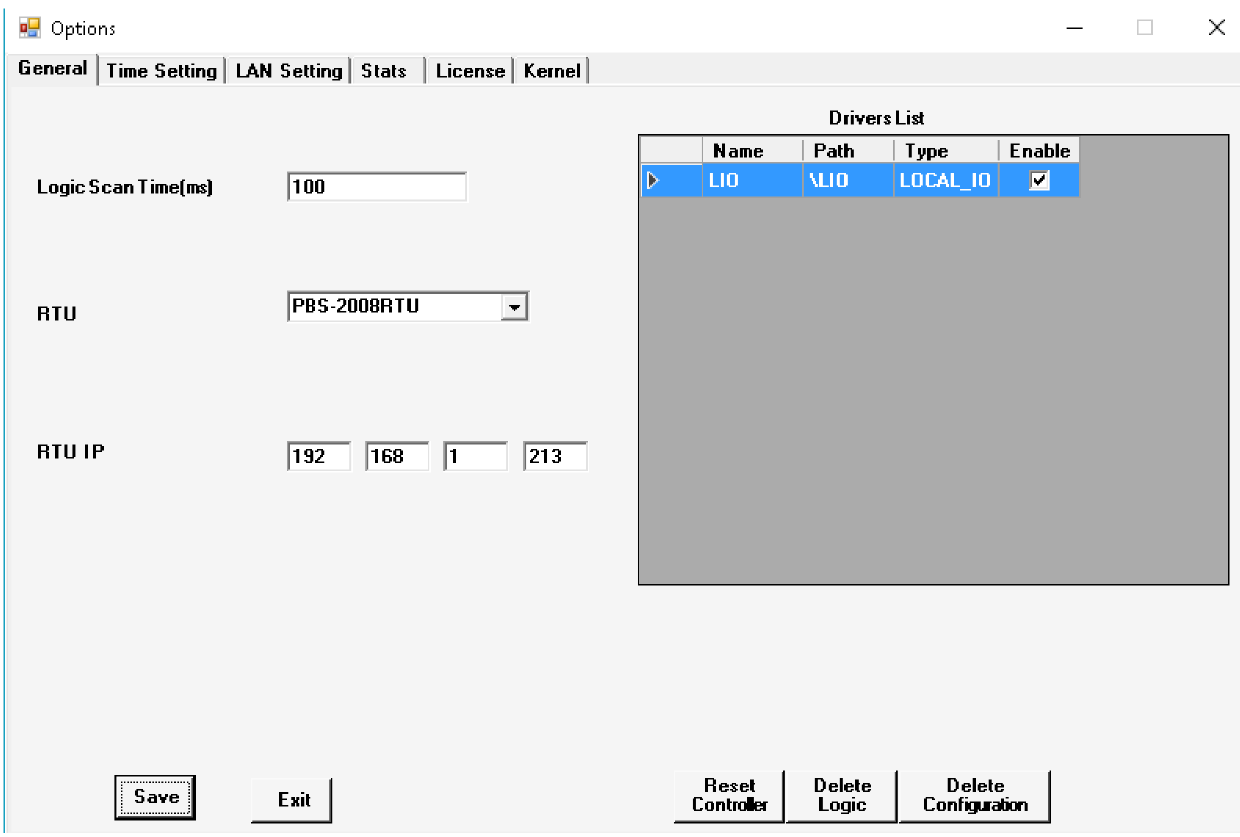


It will show list of Supported Drivers of pbsSoftLogic :

Select Local _IO and select an unique name for driver . (for example LIO)

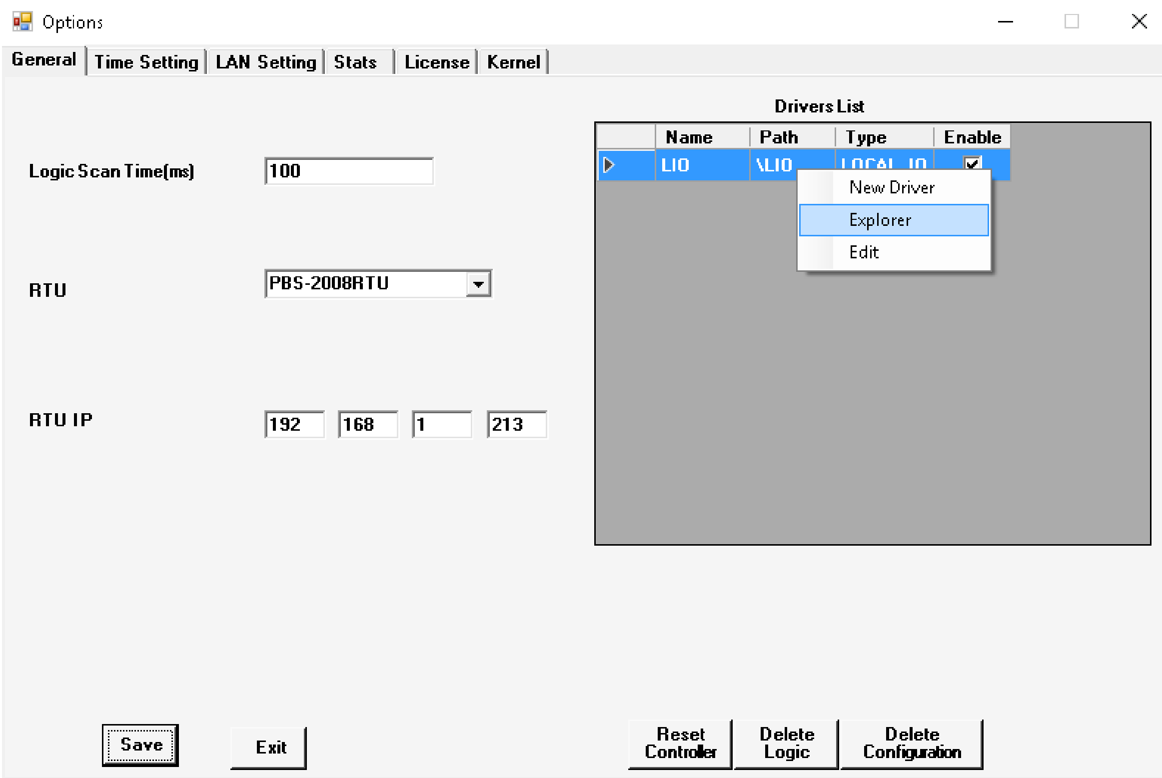


Click on Make Driver Button. pbsSoftLogic will include pbs-2008RTU configuration file to your project.

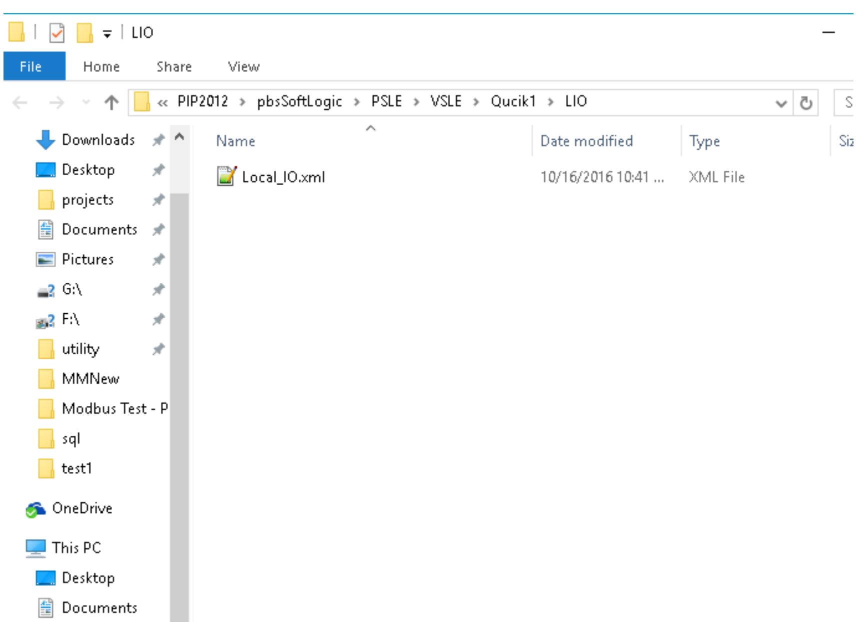


LOCAL_IO is a general driver for modeling hardware functionality of RTU. pbsSoftLogic will make different Local_IO configuration file based on RTU type .

Right click on LIO Driver and Select Explorer option.

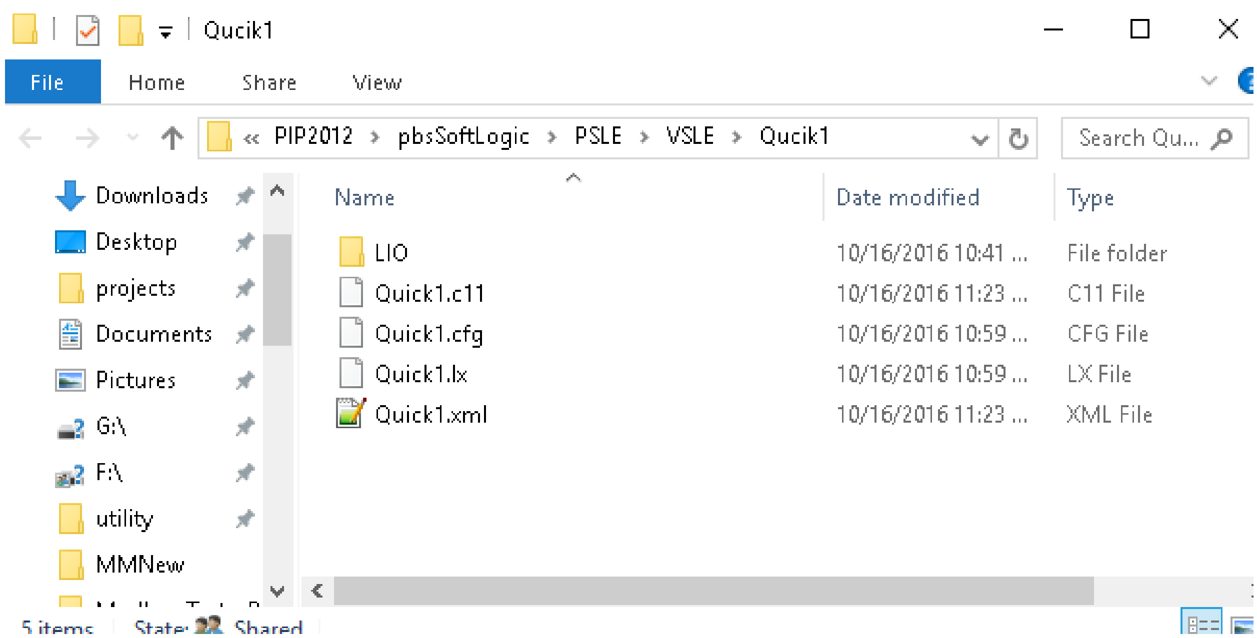


It will open LIO directory in your project:



pbsSoftLogic will make one directory for each Driver in project Directory .

If you open project directory you will see following file configuration :



Quick1.xml: source of your logic

Quick1.cfg: Project Configuration file.

Quick1.lx: Compiled Project Configuration file that is transferred to RTU

Quick1.c11: Compiled Logic that is transferred to RTU

LIO Directory: Directory for Local_IO Driver. Insider LIO directory pbsSoftLogic is make Local_IO.xml file. For pbs2008RTU Local_IO.xml file is as following:

```
<Tag Name="SYS.Reset" Type="SYS" Init="0" Address="0" />
<Tag Name="SYS.3GModemON" Type="SYS" Init="0" Address="1" />
<Tag Name="SYS.3GModemSignallevel" Type="SYS" Init="0" Address="2" />
<Tag Name="SYS.Temp1" Type="SYS" Init="0" Address="3" />
<Tag Name="SYS.Temp2" Type="SYS" Init="0" Address="4" />
<Tag Name="SYS.CNTTimer" Type="SYS" Init="200" Address="5" />
<Tag Name="SYS.AORange" Type="SYS" Init="1" Address="6" />
<Tag Name="SYS.Buzzer" Type="SYS" Init="0" Address="7" />
<Tag Name="SYS.IOScan" Type="SYS" Init="100" Address="8" />
<Tag Name="SYS.Total1" Type="SYS" Init="0" Address="9" />
<Tag Name="SYS.Total2" Type="SYS" Init="0" Address="10" />
<Tag Name="SYS.Total3" Type="SYS" Init="0" Address="11" />
<Tag Name="SYS.Total4" Type="SYS" Init="0" Address="12" />
<Tag Name="SYS.Total1RST" Type="SYS" Init="0" Address="13" />
<Tag Name="SYS.Total2RST" Type="SYS" Init="0" Address="14" />
<Tag Name="SYS.Total3RST" Type="SYS" Init="0" Address="15" />
<Tag Name="SYS.Total4RST" Type="SYS" Init="0" Address="16" />
<Tag Name="SYS.ChatterFilterCount" Type="SYS" Init="0" Address="17" />
<Tag Name="SYS.ChatterFilterBaseTimeMs" Type="SYS" Init="0" Address="18" />
<Tag Name="SYS.ChatterFilterFreezeTimeMs" Type="SYS" Init="0" Address="19" />
<Tag Name="AITag0" Type="AI" Init="0" Address="0" />
<Tag Name="AITag1" Type="AI" Init="0" Address="1" />
<Tag Name="AITag2" Type="AI" Init="0" Address="2" />
<Tag Name="AITag3" Type="AI" Init="0" Address="3" />
<Tag Name="DITag0" Type="DI" Init="0" Address="0" />
<Tag Name="DITag1" Type="DI" Init="0" Address="1" />
<Tag Name="DITag2" Type="DI" Init="0" Address="2" />
<Tag Name="DITag3" Type="DI" Init="0" Address="3" />
<Tag Name="DITag4" Type="DI" Init="0" Address="4" />
<Tag Name="DITag5" Type="DI" Init="0" Address="5" />
<Tag Name="DITag6" Type="DI" Init="0" Address="6" />
<Tag Name="DITag7" Type="DI" Init="0" Address="7" />
<Tag Name="DOTag0" Type="DO" Init="0" Address="0" />
<Tag Name="DOTag1" Type="DO" Init="0" Address="1" />
<Tag Name="DOTag2" Type="DO" Init="0" Address="2" />
<Tag Name="DOTag3" Type="DO" Init="0" Address="3" />
<Tag Name="CNTTag0" Type="CNT" Init="0" Address="0" />
<Tag Name="CNTTag1" Type="CNT" Init="0" Address="1" />
<Tag Name="CNTTag2" Type="CNT" Init="0" Address="2" />
<Tag Name="CNTTag3" Type="CNT" Init="0" Address="3" />
<Tag Name="AOTag0" Type="AO" Init="0" Address="0" />
```

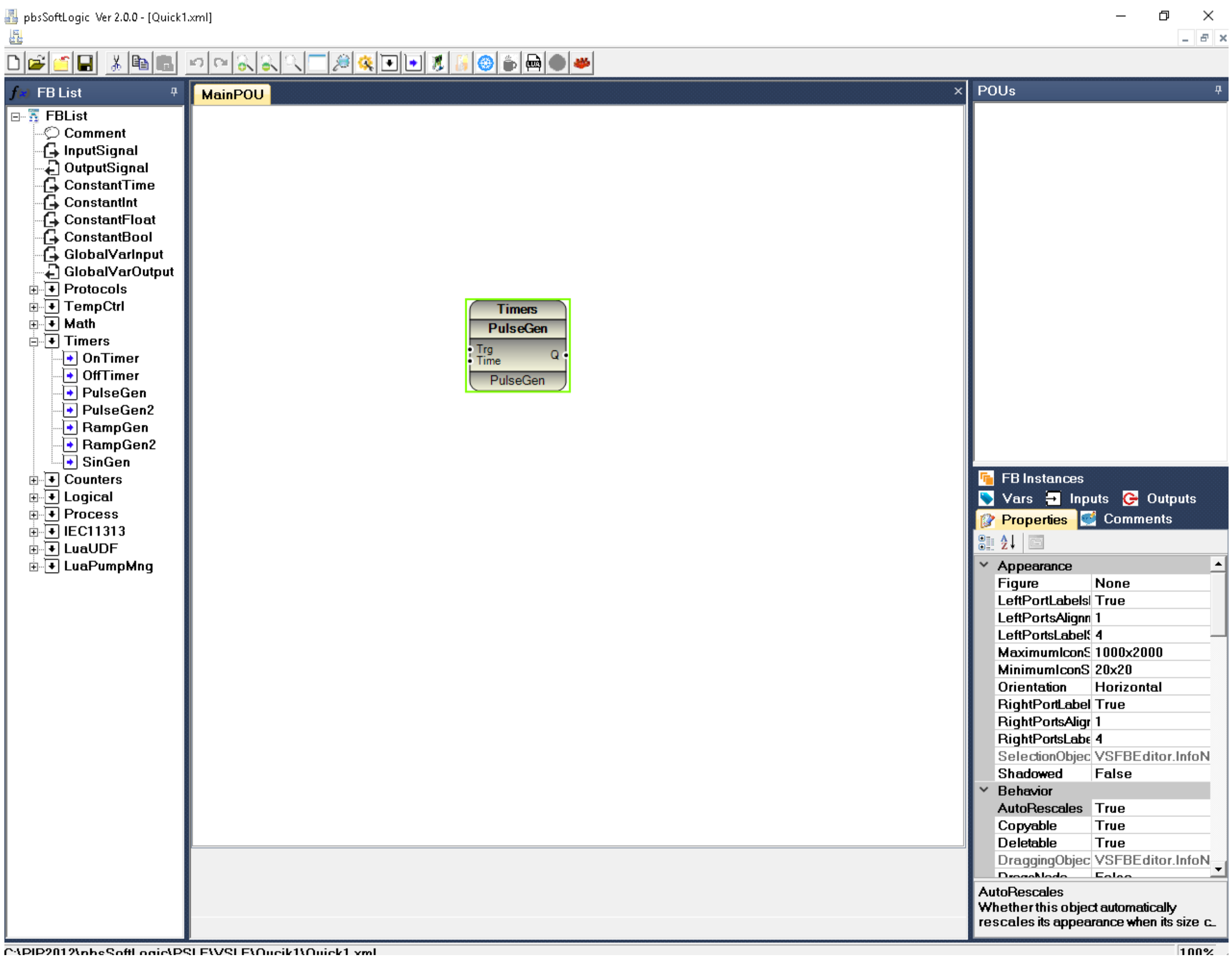
You should not change this file and only you can use it in your logic.

For detail description of above signals please refer to pbs2008RTU configuration chapter.

Step3 :

In left panel, you can see different ready FB, and in right panel Function Block application area.

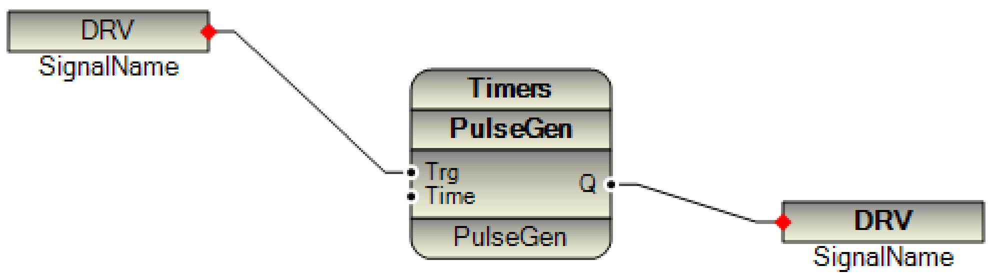
Open Timers Group and select PulseGen . Drag and Drop it to program area .



PulseGen is generating continues pulse, with same time duration (Low and High).

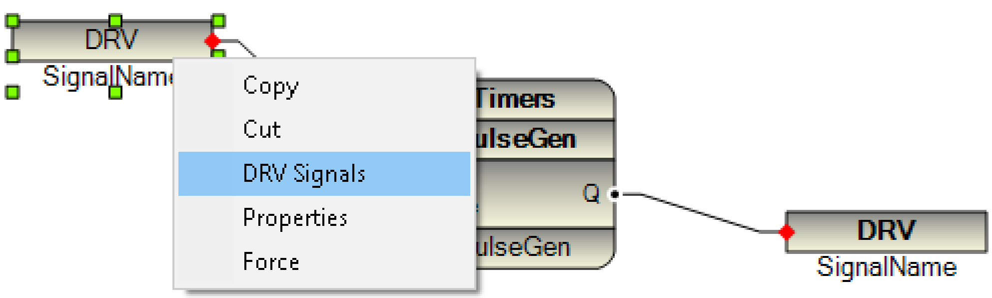
When Trg input is changing from low to high (0 to 1), Pulse train will start at Q output with Low and High Duration equal to Time input.

In FB list panel, drag and drop Inputsignal and connect it to Trg Input. Then Drag and drop OutputSignal and link it to Q output. Leave Time input without any connection.

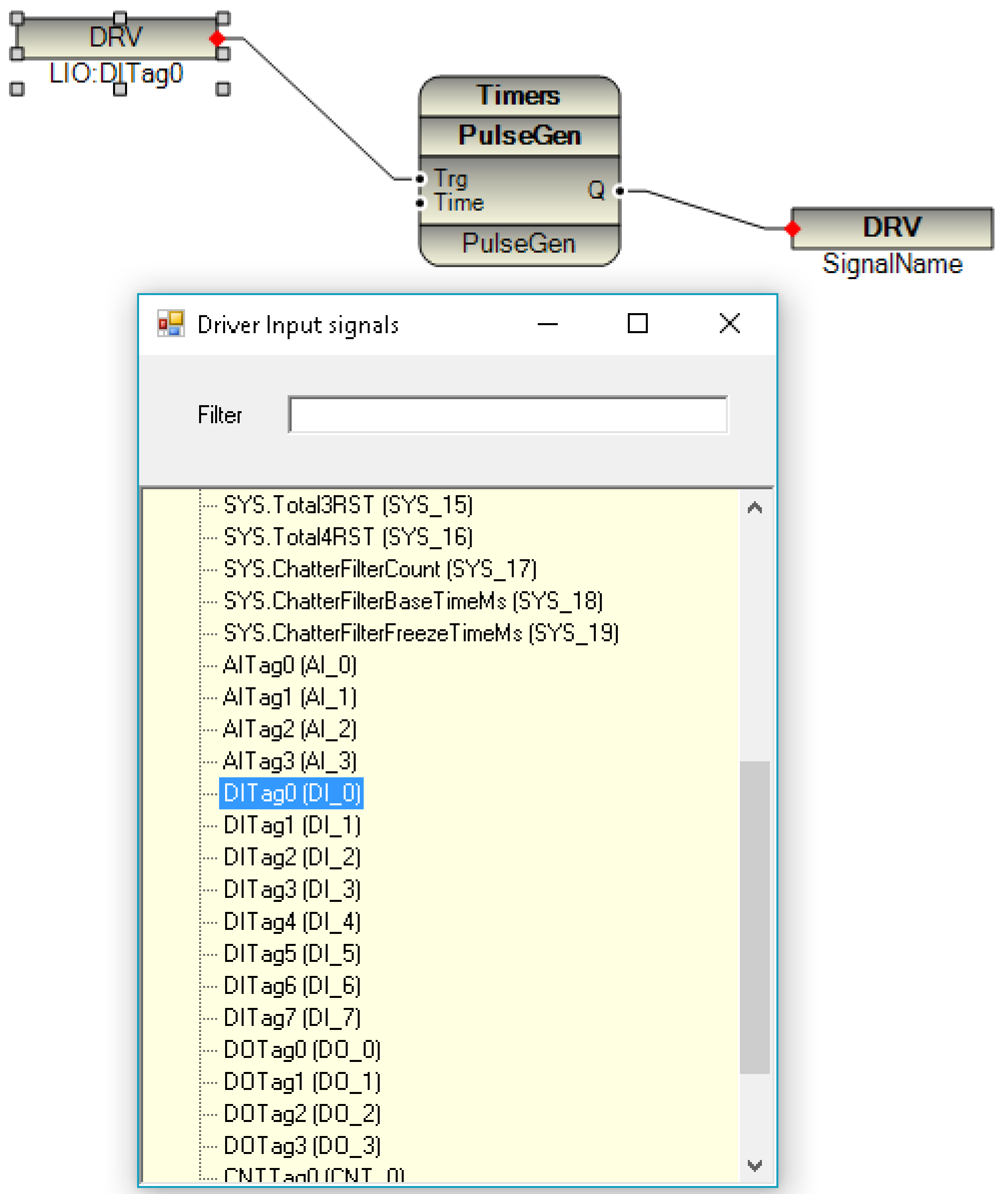


When an Input Port is not connecting to any signal, it will take default value that is preset for each FB (you can change FB Input Default values).

Click on InputSignal which is connected to Trg Input of PulseGen FB . Right click and select Driver Signals Option :



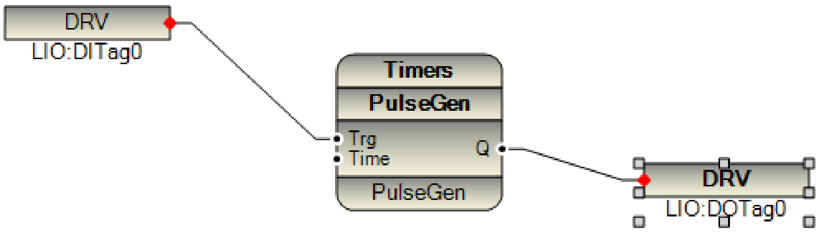
You can see list of defined driver for this project. Open LIO Driver and Double click on DITag0 Signal.

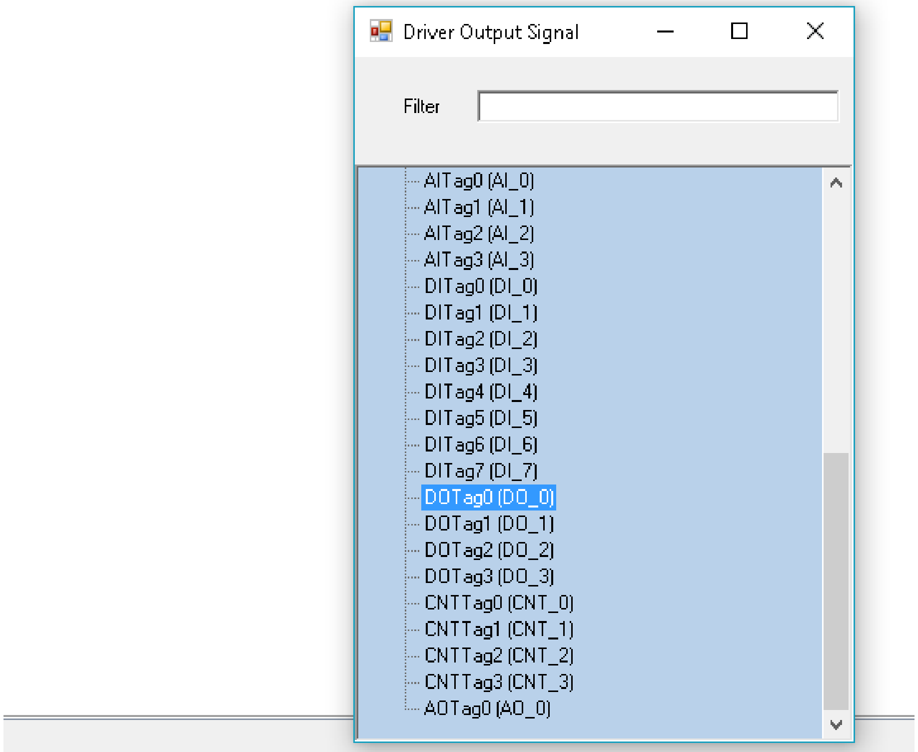


Name of signal is assigned to Input Signal Box that is connected to Trg Input of PulseGen Function Block.

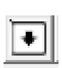
Name of Signal is combination of Driver Name + ":"+Signal Name

Click on Output Block Box that is connected to Q Output of Function Block.





Click on Save and compile button at top.

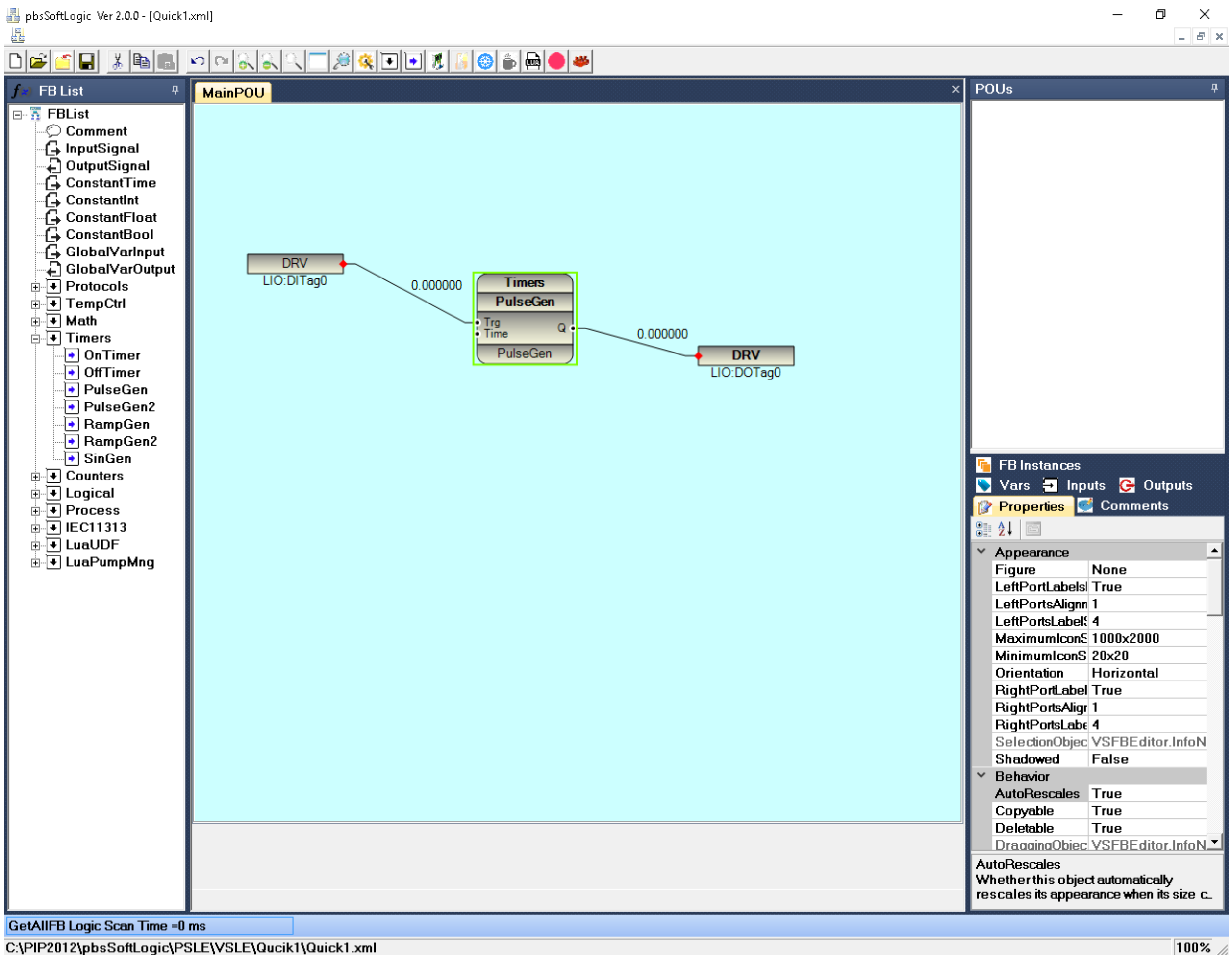


It will save and compile your logic .

Step4: simulate your logic.

Click on Simulate button at top.

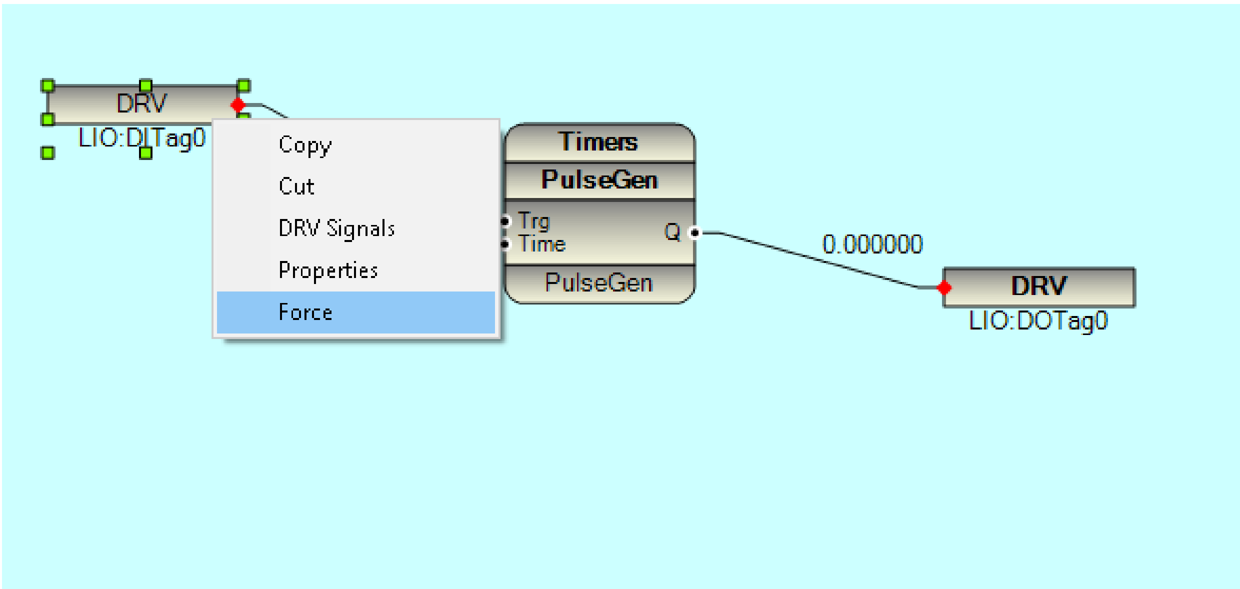
Your logic will change like following:



Online Indicator will start to blink and you can see real logic scan time at bottom part of page.

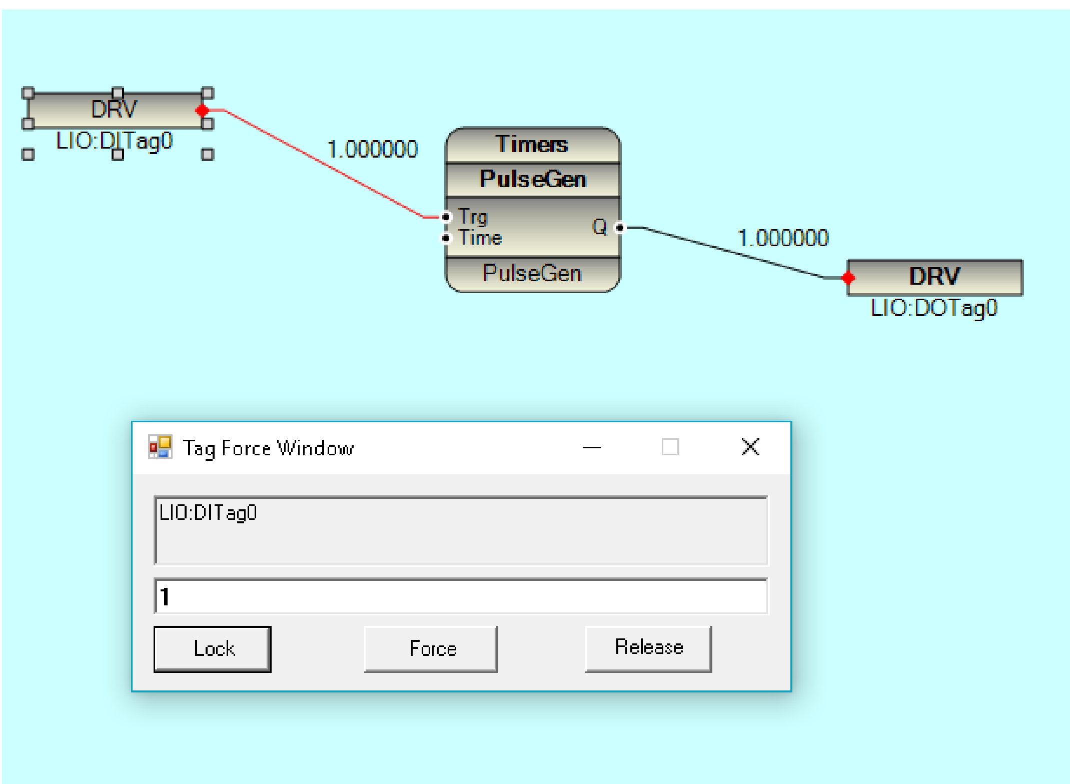
Value of all signals is showing in the link connections between elements.

Right click on LIO:TagDI0 Signal and select Force option :



You can force all Input Signals of Function blocks . It is not forcing LIO:DITag0 Signal , it will force Trg Input of PulseGen Function block .

Force signal and you can see output Signal is star to toggle between 0 and 1 .



For proper working of Simulator you need to do following configuration :

- To Be sure there are no any removable Media like USB Disk , … to your PC
- Install RAMDisk Driver from pbsSoftLogic \RamDisDrv Directory
- Simulator is using RAM Disk to keep Static data of function blocks.
- Open options.xml file in pbsSoftLogic Directory and set RAMDisk Path TempPath option .

<Node>

<Name>ResourcePath</Name>

<Desc>Resource Directory Path</Desc>

<Value>e:\Resource</Value>

</Node>

<Node>

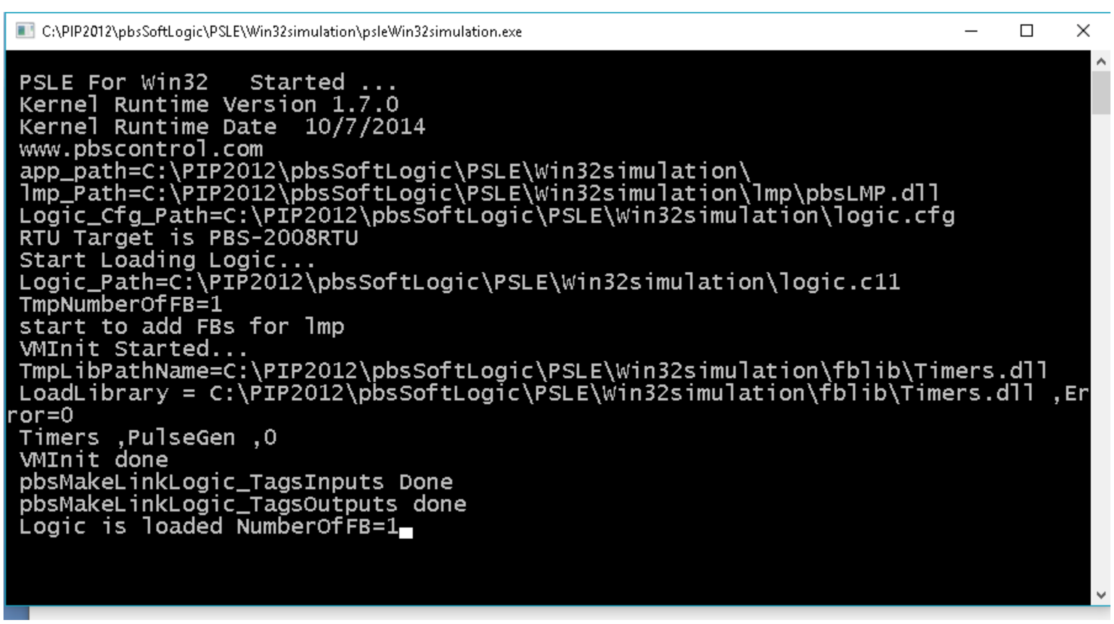
<Name>TempPath</Name>

<Desc>Temp Directory Path</Desc>

<Value>e:\Temp</Value>

</Node>

Simulator is runtime kernel of pbsSoftLogic for Win32 . you can see when you click on Simulator button and task bar a new program will run .



Simulator is located at pbsSoftLogic\ Win32simulation Directory.

When you click Simulator button, pbsSoftLogic will copy Quick1.c11 and Quick1.lx to Win32Simulation directory and change name to logic.c11 and logic.cfg.

Also pbsSoftLogic will copy all Lua Codes from VSLELib to Win32Simulation\fblib Directory.

Then psleWin32simulation.exe will run by platform. If psleWin32simulation.exe is already running, first it will close and run it again.

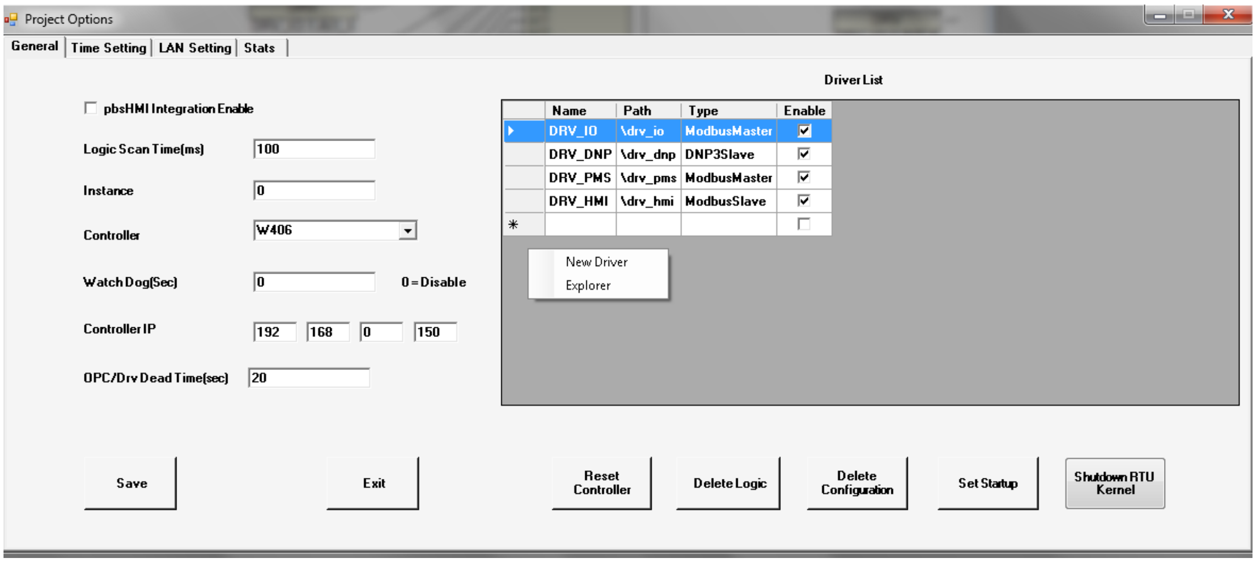
Warm Update and Clod update buttons are not supported for simulation because each time you run simulator it will run Simulator from scratch.

6 – Modbus Master Configuration and integration with remote I/O Modules

PbsSoftLogic supports Modbus Master Driver for communication with I/O Modules and other Modbus Slave Devices. You can set modbus master driver communication parameter from project setting page.

In project setting page, you can see list of configured drivers for your logic.

Right click on driver list, you can add a new driver or explore defined driver.



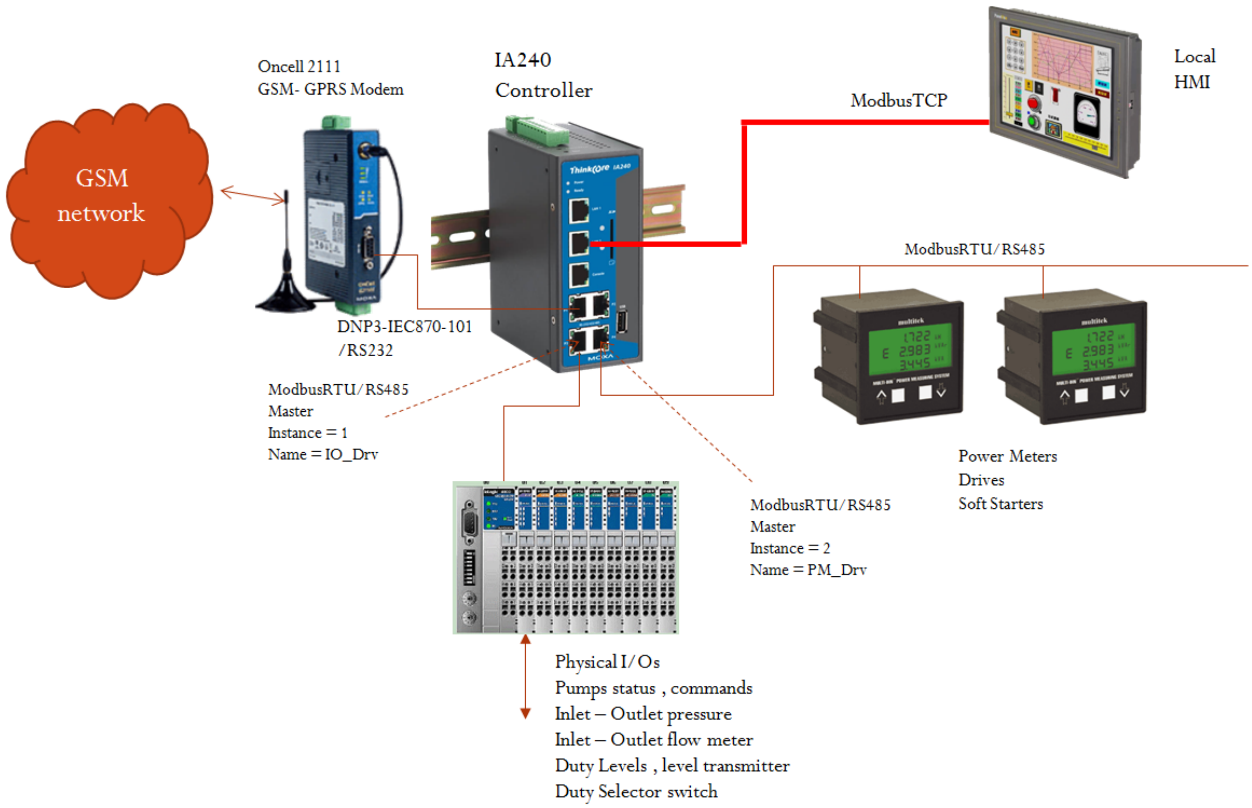
For defining a new Modbus Master Driver, right click on Driver list and select New Driver.

In new driver page, select communication protocol, Type Driver Name and select Driver instance.

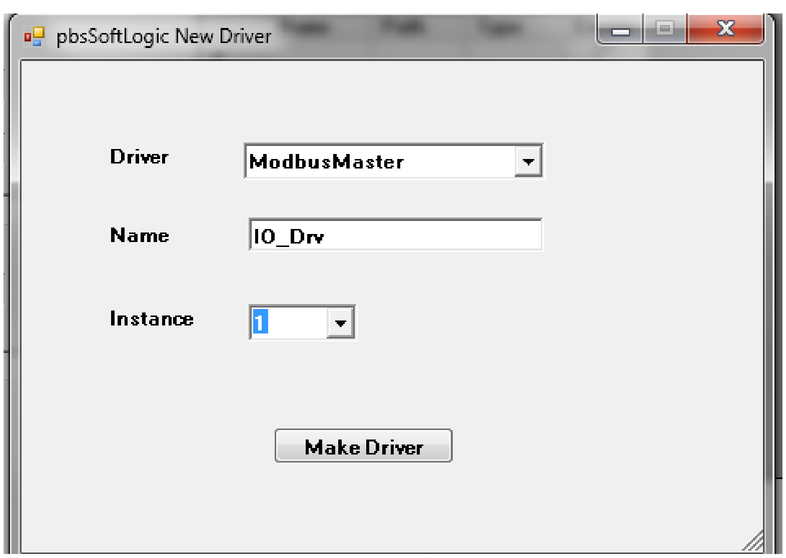
Driver : pbsSoftLogic supports many protocols . Select ModbusMaster for Modbus Master protocol.

Name: Unique Driver Name.

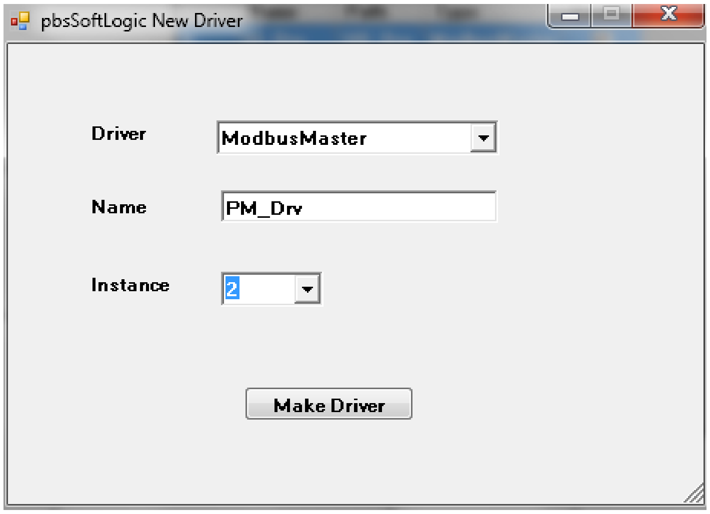
Instance = Instance number for each type of Driver. If you have two Modbus Master Network in project , then you need to define two ModbusMaster Driver with Different name and different instance number. Look at following example, IA240 should connect to I/O Modules and Power monitor network by two different Modbus Master networks.



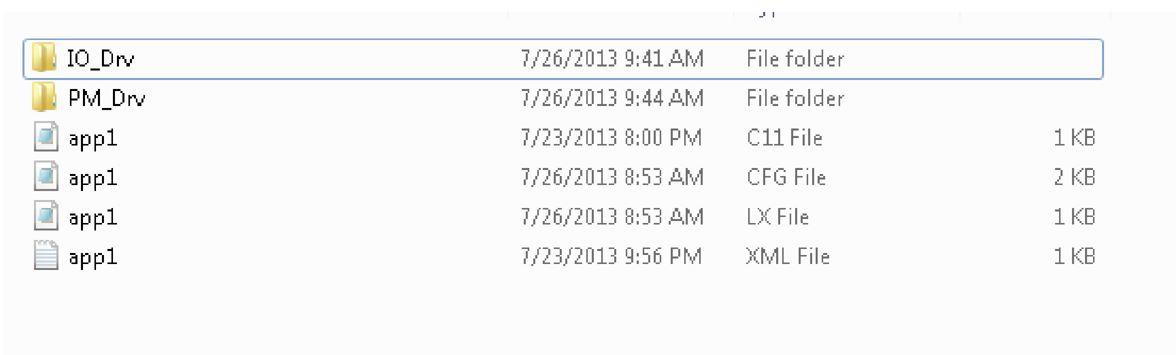
Configuration for Modbus Master Driver for I/O Modules:



Configuration for Modbus Master Driver for Power Monitor Devices:



Click on Make Driver button. pbsSoftlogic will make separate directories with same name of Driver at logic path .



Following items are adding to Driver list in setting page:

Right click on IO_Drv and select explorer. pbsSoftLogic will open IO_Drv directory .

Three files are generated by pbsSoftlogic at this directory.

Options.xml : communication parameter . Like Serial Port, Baud rate …

ModbusBlocks.xml : Modbus Block Definitions

ModbusTags.xml : Modbus Tags Definitions

Edit options.xml file. You can set following parameters for ModbusMaster Driver. Each XML node has a name (Don't change it), Desc (Don't change it) and Value (Set based on Description)

```
<Node>
    <Name>PhysicalLayer</Name>
    <Desc>RS232 , RS485 , RS424 , TCP</Desc>
    <Value>RS232</Value>
</Node>
```

PhysicalLayer : For Modbus RTU Select one of RS232 , RS485 and RS422 . For ModbusTCP select TCP

```
<Node>
    <Name>COMPort</Name>
    <Desc>Serial Port for Communication 1,2,3,4,5,...</Desc>
    <Value>1</Value>
</Node>
```

COMPort :will be used for ModbusRTU protocol .

```
<Node>
    <Name>BaudRate</Name>
    <Desc>9600,19200,36400,52700,115200</Desc>
    <Value>9600</Value>
</Node>
```

BaudRate :will be used for ModbusRTU protocol .

```
<Node>
    <Name>DataBit</Name>
    <Desc>7,8</Desc>
    <Value>8</Value>
</Node>
```

DataBit :will be used for ModbusRTU protocol .

```
<Node>
    <Name>StopBit</Name>
    <Desc>1,2</Desc>
    <Value>1</Value>
</Node>
```

StopBit :will be used for ModbusRTU protocol .

```
<Node>
    <Name>Parity</Name>
    <Desc>None,Even,Odd</Desc>
    <Value>None</Value>
</Node>
```

Parity :will be used for ModbusRTU protocol .

```
<Node>
    <Name>Instance</Name>
    <Desc>Instance</Desc>
    <Value>1</Value>
</Node>
```

Instance: Driver Instance Number.

```
<Node>
    <Name>TCPPort</Name>
    <Desc>TCPPort</Desc>
    <Value>502</Value>
</Node>
```

TCPPort: ModbsuTCP Port number. Default Value 502

```
<Node>
    <Name>ContPoll</Name>
    <Desc>Continous polling of Slaves , 1= Enable , 0= Poll Slave by System.Poll Signal</Desc>
    <Value>0</Value>
</Node>
```

ContPoll: This is used for controlling Modbus Slave Device Polling time .

If ContPoll=1 , then RTU will poll slaves permanently

If ContPoll=1 RTU will poll Slaves based on Value of SYS.Poll Signal .

-When SYS.Poll is 1 in your logic , RTU will poll Slaves

-When SYS.Poll is 0 in your logic , RTU not polling Slaves

WakeUpString : Some Modbus Slaves (Specially in Gas Distribution SCADA) start to communicate with RTU if they receive wakeup string . Wakeup string has following format: x,x,x,x,x

X is a decimal number and separated by ,

Example: 255,255,255,255,255

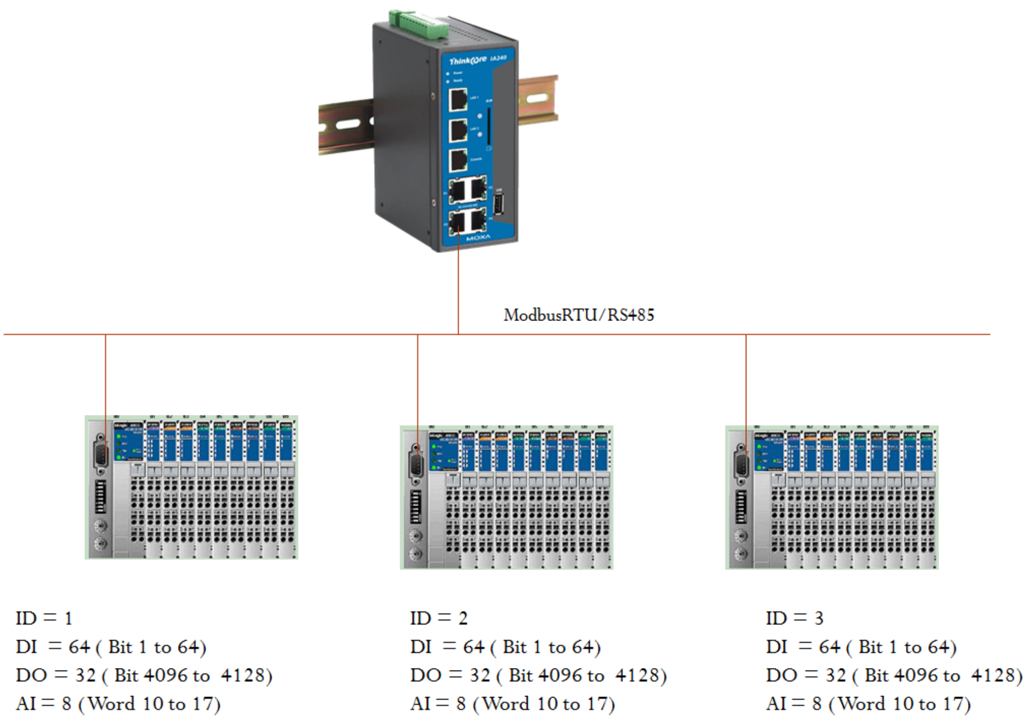
If WakeUpString is Blank , then it is disabled in driver.

WakeUpString and ContPoll should use with each other . for using WakeUpString you should set ContPoll to 0 and control Slave Polling in your logic . Every time SYS.Poll is changed from 0 to 1 , WakeUp String is send to Slave device .

There is a specific Function Block in Process Group (Scheduler) . you can use this FB to control Slave Device Polling .

ModbusBlocks.xml : pbsSoftlogic Modbus modeling is based on Block Concept.

We start with a simple example to show concepts of Block. Suppose we want to configure Modbus network for following system:



ModbusBlocks.xml for above configuration:

```
<?xml version="1.0"?>
<OPCSrvTags>
     <Version>1.0.0</Version>
     <Block Name="DI1" Type="BI" SlaveID="1" IP="" StartAdd="1" Count="64" Wait="200" Enable="True" />
     <Block Name="DO1" Type="BO" SlaveID="1" IP="" StartAdd="4096" Count="32" Wait="200" Enable="True" />
     <Block Name="AI1" Type="AI" SlaveID="1" IP="" StartAdd="10" Count="8" Wait="200" Enable="True" />
     <Block Name="Diag1" Type="SYS" SlaveID="1" IP="" StartAdd="100" Count="8" Wait="100" Enable="True" />

     <Block Name="DI2" Type="BI" SlaveID="2" IP="" StartAdd="1" Count="64" Wait="200" Enable="True" />
     <Block Name="DO2" Type="BO" SlaveID="2" IP="" StartAdd="4096" Count="32" Wait="200" Enable="True" />
     <Block Name="AI2" Type="AI" SlaveID="2" IP="" StartAdd="10" Count="8" Wait="200" Enable="True" />
     <Block Name="Diag2" Type="SYS" SlaveID="2" IP="" StartAdd="100" Count="8" Wait="100" Enable="True" />


     <Block Name="DI3" Type="BI" SlaveID="3" IP="" StartAdd="1" Count="64" Wait="200" Enable="True" />
     <Block Name="DO3" Type="BO" SlaveID="3" IP="" StartAdd="4096" Count="32" Wait="200" Enable="True" />
     <Block Name="AI3" Type="AI" SlaveID="3" IP="" StartAdd="10" Count="8" Wait="200" Enable="True" />
     <Block Name="Diag3" Type="SYS" SlaveID="3" IP="" StartAdd="100" Count="8" Wait="100" Enable="True" />

</OPCSrvTags>
```

Block Name = Unique name of Block.

Type: Block Type

BI = DI: Digital Input = Modbus Input status (Read from Slave) Send FC = 2

BO= DO: Digital Output = Modbus Coil(Write to slave) , Send FC = 5

BOS=DOS: Digital Output Status = Modbus Coils Status (Read from Slave) Send FC = 1

AI: Analog Input = Modbus input Register (2 bytes , Signed) (Read from Slave) Send FC = 4

AO: Analog Output = Modbus Holding Register (2 bytes , Signed) (Write to slave) Send FC = 6

AOS: Analog Output Status = Modbus Holding Register status (2 bytes , Signed) (Read from Slave) Send FC = 3

FI : Float Input . use same Address Space of AI . Each FI tag is getting two AI register . (4 Bytes) (Read from Slave) Send FC = 4

SFI : Swap Float Input . use same Address Space of AI . Each SFI tag is getting two AI register (Read from Slave) Send FC = 4

LI : Long Input . use same Address Space of AI . Each LI tag is getting two AI register . (4 bytes , Signed) (Read from Slave) Send FC = 4

SLI : Swap Long Input . use same Address Space of AI . Each SLI tag is getting two AI register . (Read from Slave) Send FC = 4

FO : Float Output . use same Address Space of AO . Each FO tag is getting two AO holding register . (Write to slave) Send FC = 16

SFO : Swap Float Output . use same Address Space of AO . Each SFO tag is getting two AO holding register . (Write to slave) Send FC = 16

FOS : Float Output Status . use same Address Space of AO . Each FOS tag is getting two AO holding register . (Read from Slave) Send FC = 3

SFOS : Swap Float Output Status . use same Address Space of AO . Each SFOS tag is getting two AO holding register . (Read from Slave) Send FC = 3

LO : Long Output . use same Address Space of AO . Each LO tag is getting two AO holding register . (Write to slave) Send FC = 16

SLO : Swap Long Output . use same Address Space of AO . Each SLO tag is getting two AO holding register . (Write to slave) Send FC = 16

LOS : Long Output Status . use same Address Space of AO . Each LOS tag is getting two AO holding register . (Read from Slave) Send FC = 3

SLOS : Swap Lang Output Status . use same Address Space of AO . Each SLOS tag is getting two AO holding register . (Read from Slave) Send FC = 3

SYS: Internal for pbsSoftLogic . Can be used for reading status of communication. It has 4 Signal: Online : Shows Slave is Working properly and answering to RTU Request

SendNum : Number of Send request from RTU to Slave . It is changing from 0 to 32000

RecNum: Number of Recived messages from Slave . It is changed between 0 to 32000

Poll : When ConPoll is equal to 0 , then Driver is polling Slaves based on value of Poll Signal .

SlaveID = ID of Slave Device.

IP = IP address of Slave Device. Will use for ModbusTCP network.

StartAddress = Start Address of Modbus Block . For Digital (Bit) and for analog (Word)

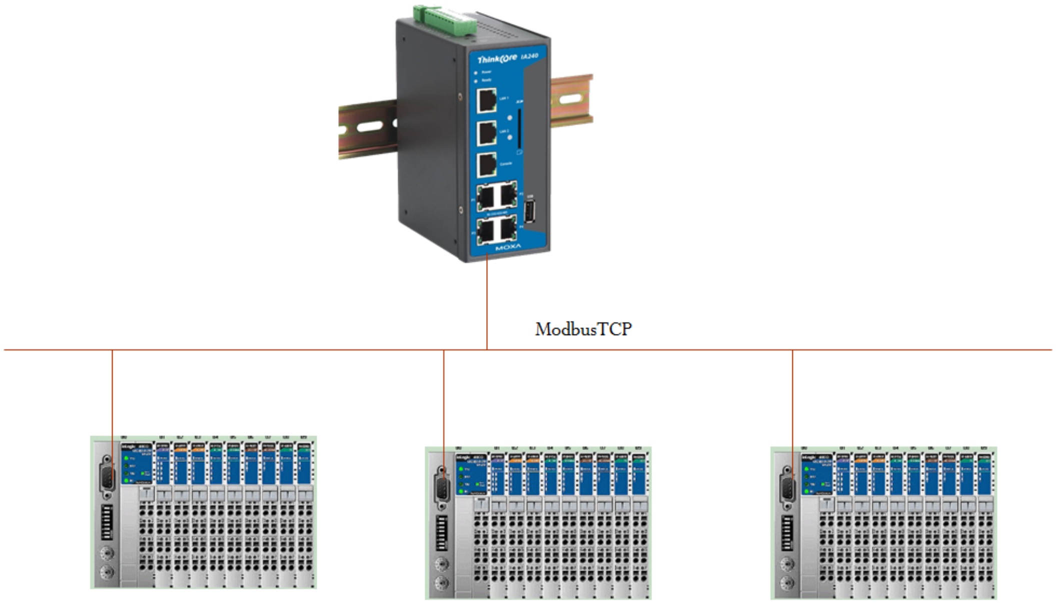
Count = Channel Count , for FI , LI , SFI , SLI , FO,LO,SFO,SLO,… pbsSoftLogic Kernel will automatic read double register or Holding register .

Wait = Time for driver to wait for getting answer from Slave Device.

Enable = It is Enable or Not. If it is not enable, it is not polling by driver.

For SYS Block type, Start Address is dummy and it is not use by driver. So always put it 100. If you have another block with same start address, it is not making any conflict.

ModbusBlocks.xml file for ModbusTCP :



ID = 1
IP = 192.168.1.100
DI = 64 (Bit 1 to 64)
DO = 32 (Bit 4096 to 4128)
AI = 8 (Word 10 to 17)

ID = 1
IP = 192.168.1.101
DI = 64 (Bit 1 to 64)
DO = 32 (Bit 4096 to 4128)
AI = 8 (Word 10 to 17)

ID = 1
IP = 192.168.1.102
DI = 64 (Bit 1 to 64)
DO = 32 (Bit 4096 to 4128)
AI = 8 (Word 10 to 17)

ModbusBlocks.xml file for above configuration:

```
<?xml version="1.0"?>
<OPCSrvTags>
      <Version>1.0.0</Version>
      <Block Name="DI1" Type="BI" SlaveID="1" IP="192.168.1.100" StartAdd="1" Count="64" Wait="200" Enable="True" />
      <Block Name="DO1" Type="BO" SlaveID="1" IP="192.168.1.100" StartAdd="4096" Count="32" Wait="200" Enable="True" />
      <Block Name="AI1" Type="AI" SlaveID="1" IP="192.168.1.100" StartAdd="10" Count="8" Wait="200" Enable="True" />
      <Block Name="Diag1" Type="SYS" SlaveID="1" IP="192.168.1.100" StartAdd="100" Count="8" Wait="100" Enable="True" />

      <Block Name="DI2" Type="BI" SlaveID="1" IP="192.168.1.101" StartAdd="1" Count="64" Wait="200" Enable="True" />
      <Block Name="DO2" Type="BO" SlaveID="1" IP="192.168.1.101" StartAdd="4096" Count="32" Wait="200" Enable="True" />
      <Block Name="AI2" Type="AI" SlaveID="1" IP="192.168.1.101" StartAdd="10" Count="8" Wait="200" Enable="True" />
      <Block Name="Diag2" Type="SYS" SlaveID="1" IP="192.168.1.101" StartAdd="100" Count="8" Wait="100" Enable="True" />


      <Block Name="DI3" Type="BI" SlaveID="1" IP="192.168.1.102" StartAdd="1" Count="64" Wait="200" Enable="True" />
      <Block Name="DO3" Type="BO" SlaveID="1" IP="192.168.1.102" StartAdd="4096" Count="32" Wait="200" Enable="True" />
      <Block Name="AI3" Type="AI" SlaveID="1" IP="192.168.1.102" StartAdd="10" Count="8" Wait="200" Enable="True" />
      <Block Name="Diag3" Type="SYS" SlaveID="1" IP="192.168.1.102" StartAdd="100" Count="8" Wait="100" Enable="True" />

</OPCSrvTags>
```

Modbus Master Driver is polling Devices based on Modbus Block File. (For ModbusRTU and ModbusTCP)

For Above ModbusBlocks.xml file , Modbus Driver will do following sequence :

1- Send DI1 Block , Update Diag1 Send Counter
2- Wait for 200 msec
3- Get Answer and update Modbus Tags , Update Diag1 Rec Counter , Diag1.ErrorCounter = 0 , Diag1.Online = 1
4- If There is no answer from Device Increase Diag1.ErrorCounter , if it Is more than 3 , Make Device offline Diag1.Online = 0

5- Check Write Queue for Writing on DO or AO Blocks , If there is any item in Write Queue , Write it to Device otherwise send Request for Next Block
6- Send AI1 Block , Update Diag1.SendNum
7- Wait for 200 Msec
8- Get Answer and update Modbus Tags , Update Diag1 Rec Counter , Diag1.ErrorCounter = 0 , Diag1.Online = 1
9- If There is no answer from Device Increase Diag1.ErrorCounter , if it Is more than 3 , Make Device offline Diag1.Online = 0
10- Check Write Queue for Writing on DO or AO Blocks , If there is any item in Write Queue , Write it to Device otherwise send Request for Next Block
11- Repeat Steps 1 to 10 for Device 2.
12- Repeat Steps 1 to 10 for Device 3.

Scan Time Calculation: for above configuration Scan time for whole signals will be calculate as following:

200(DI1)+50+200(AI1)+50+

200(DI2)+50+200(AI2)+50+

200(DI3)+50+200(AI3)+50 = 3000 msec = 3 sec . (if there is no write command)

If you want to reduce scan time, you can increase BaudRate and reduce Block Wait time.

Or you can separate Modbus Network to two or three separate network.

ModbusTags.xml : All Modbus Tags will define in this file . FBEditor used this file for accessing tags.

Modbus Tag has following format In ModbusTags,xml file :

```xml
<?xml version="1.0"?>
<OPCSrvTags>
    <Version>1.0.0</Version>
    <Tag BlockName="DI1" Address="0" Name="P1_Auto" />
    <Tag BlockName="DI1" Address="1" Name="P1_Run" />
    <Tag BlockName="DI1" Address="2" Name="P1_Trip" />
    <Tag BlockName="DI1" Address="3" Name="P2_Auto" />
    <Tag BlockName="DI1" Address="4" Name="P2_Run" />
    <Tag BlockName="DI1" Address="5" Name="P2_Trip" />
    <Tag BlockName="DI1" Address="6" Name="SP_Auto" />
    <Tag BlockName="DI1" Address="7" Name="SP_Run" />
    <Tag BlockName="DI1" Address="8" Name="SP_Trip" />


    <Tag BlockName="DO1" Address="4096" Name="P1_StartCMD" />
    <Tag BlockName="DO1" Address="4097" Name="P2_StartCMD" />
    <Tag BlockName="DO1" Address="4098" Name="SP_StartCMD" />
    <Tag BlockName="DO1" Address="4099" Name="EF_StartCMD" />
    <Tag BlockName="DO1" Address="4100" Name="RTU_Healthy_LAMP" />
    <Tag BlockName="DO1" Address="4101" Name="DOSpare4101" />
    <Tag BlockName="DO1" Address="4102" Name="TakeOverFromRTU" />
    <Tag BlockName="DO1" Address="4103" Name="DOSpare4103" />
    <Tag BlockName="DO1" Address="4104" Name="FDOSPump_StartCMD" />
    <Tag BlockName="DO1" Address="4105" Name="DOSpare4105" />
    <Tag BlockName="DO1" Address="4106" Name="DOSpare4106" />
    <Tag BlockName="DO1" Address="4107" Name="DOSpare4107" />
    <Tag BlockName="DO1" Address="4108" Name="DOSpare4108" />
    <Tag BlockName="DO1" Address="4109" Name="DOSpare4109" />
    <Tag BlockName="DO1" Address="4110" Name="DOSpare4110" />
    <Tag BlockName="DO1" Address="4111" Name="DOSpare4111" />
```

Blockname : Same Block name in ModbusBlocks.xml

Address = Modbus Tag Address. Start from 0. No need to Write like Modbus Format (like 10001) . Just write address of Tag . If Block Is starting by 4096 , then you need to start Tag Address from 4096 and add one by one all tags . Please define all Tags for a block .

Name = Modbus Tag Name . should be unique for Modbus Master Driver.

For All other salve drivers (Modbus, DNP3 and IEC8705) Tag Name should be unique .

For Diag Block you need to define following tags :

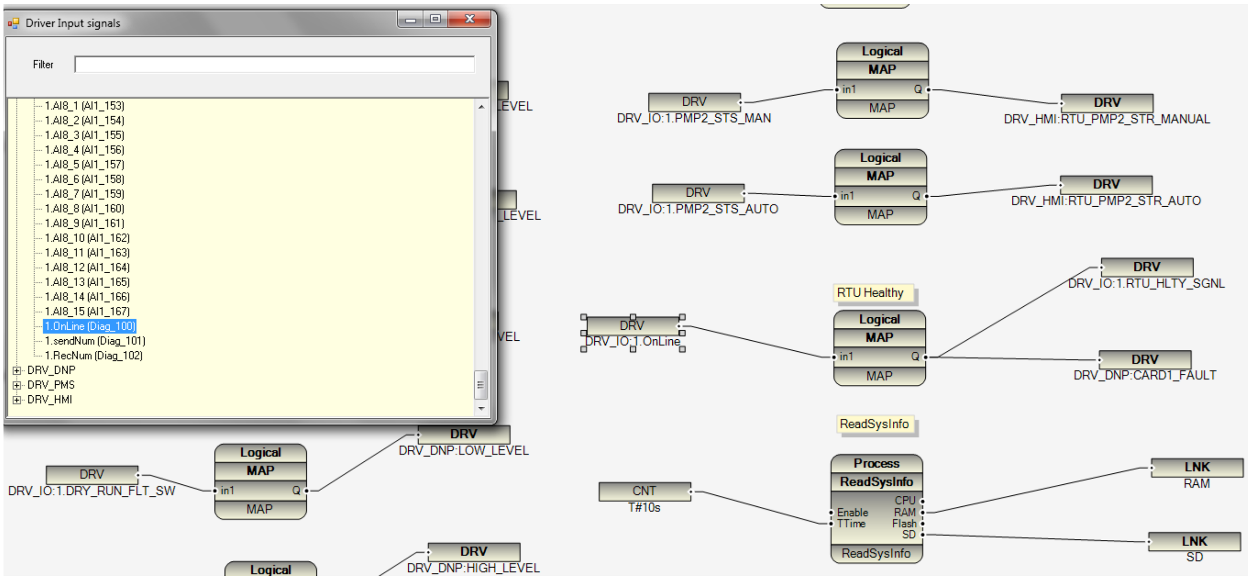
```xml
<Tag BlockName="Diag" Address="100" Name="OnLine" />
<Tag BlockName="Diag" Address="101" Name="sendNum" />
<Tag BlockName="Diag" Address="102" Name="RecNum" />
```

First tag is Online . If device is answer to Driver request its value is 1 otherwise it is 0.

sendNum : Number of Send Request by driver . Maximum value is 10,000

RecNum : Number of received Answer to driver . Maximum value is 10,000

You can use above tags like normal Modbus Tag in your logic.



Number of Modbus Master Driver for each controller : 8 Instance

Number of Modbus tags for each Instance: 1024

Number of Modbus Blocks for each instance: 64

Number of Modbus Devices for each instance: 32

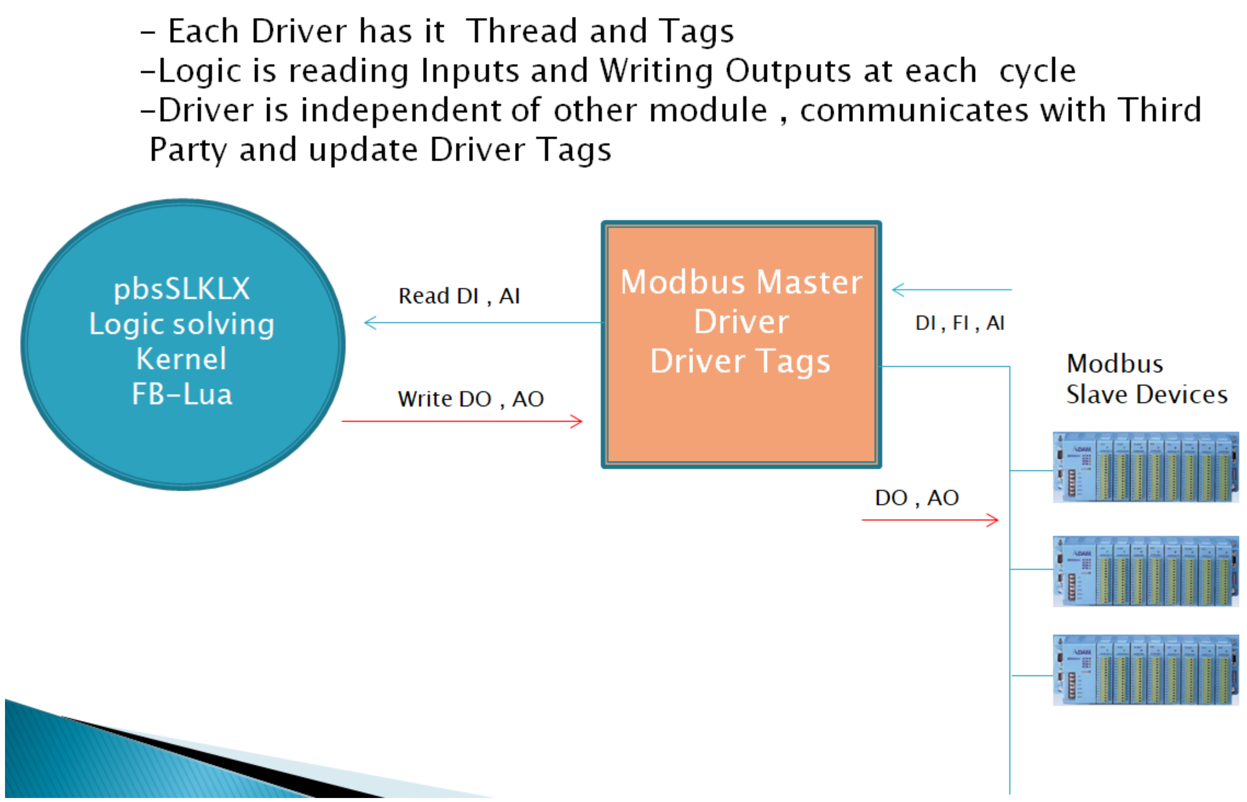
Note : it is recommended that first using Modbus Tester utility Like Modscan (https://www.win-tech.com/html/modbus1.htm) to find detail of Modbus Tags address inside Slave devices (Power meter , IO Modules , SoftStarter , Flow Computers , …) and then configure pbsSoftLogic Modbus Master Blocks parameters .

Normally when you read /write a Modbus Block by Modscan , you should reduce One address from Block start Address in Modscan and set in pbsSoftLogic Modbus Block Definition .

Suppose in Modscan you read an Input Register Block from Address 101 and read 32 register.

In pbsSoftLogic you should set Block Start Address to 100 and Count to 32.

In following figure you can see Modbus Master Driver and its relation with pbsSLKLX kernel.



Modbus Master Driver Loading Steps :

- pbsSLKLX is reading logic.cfg file and find there is Modbus Master Driver in Configuration
- pbsSLKLX Load Modbus Master Driver from /home/pbsLX/drvlib/mmix/libpbsModbusMLx.so
- pbsSLKLX will pass Driver Parameters and Tags based on logic.cfg file and Initialize driver
- modbus Master Driver (libpbsModbusMLx.so) will make new CPU thread and start to read write Modbus Blocks from Modbus Slaves and update in ternal Driver Tags .
- pbsSLKLX has access to Modbus Driver Internal Tags by unified API Interface

7- Modbus Slave Configuration

pbssoftLogic supports Modbus slave Driver for communication with HMI Devices or any other Modbus Master systems .

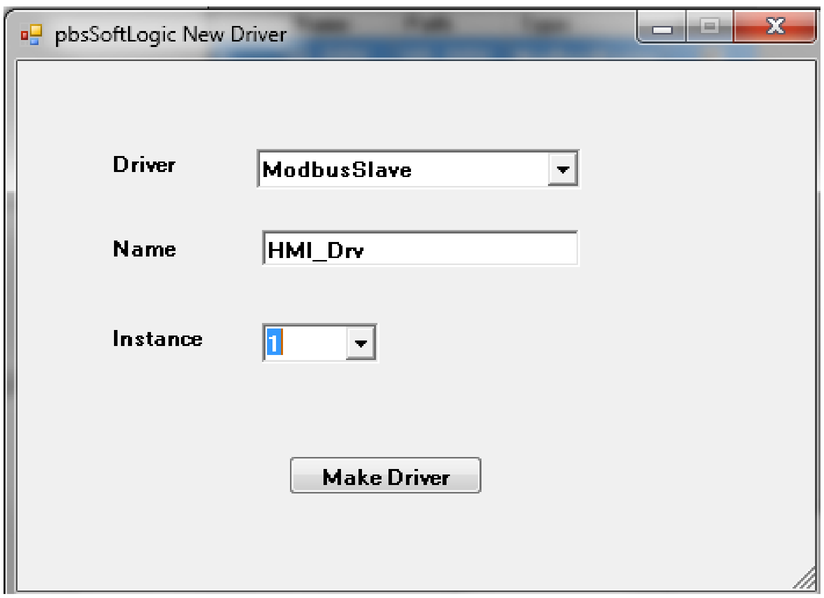
You can run Modbus master and salve on the same Controller in the same time but they should have separate resource. For example COM Port 1 can be Modbus Master and COM Port 2 Modbus Slave.

There is Software limitation for number of Instances for any protocol in pbsSoftLogic (maximum 8) . You can run 8 instances of Modbus Slave on the same Controller and connect to different modbus master in the same time.

Totally you can define 1024 Tags for each Modbus Slave Instances.

For Adding Modbus Slave Driver to an Application, open Project settings and right click on Driver list.

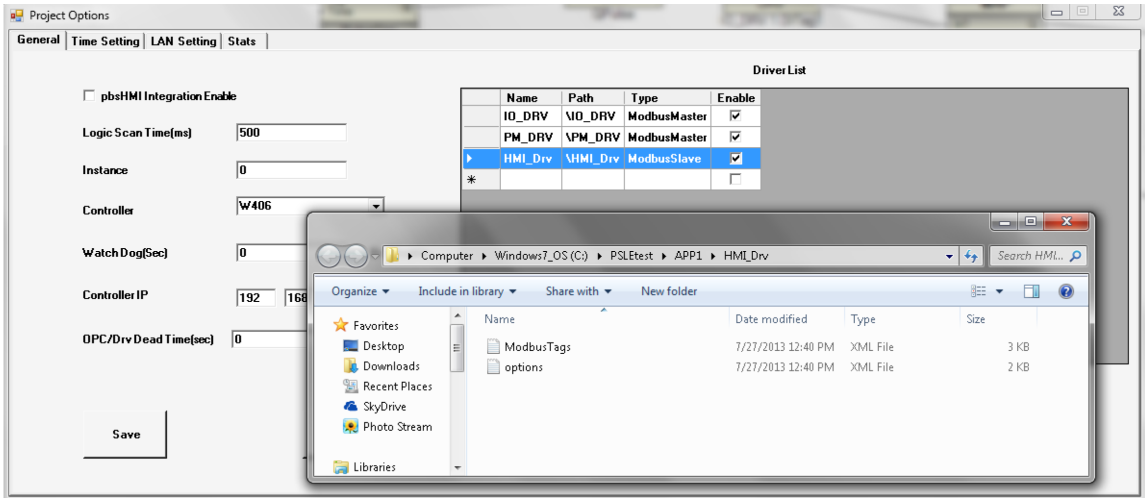
Select ModbusSlave Driver and fill other fields.



Click on make Driver Button. pbsSoftlogic will make basic files for Modbus Slave Communication .

Close this page, Modbus Slave Driver is added to Driver list.

Right click on Modbus Slave Driver and select explorer. You can see two files in HMI_Drv directory.



Options.xml : communication basic parameter

ModbusTags.xml : Modbus Slave Tags

<Node>

<Name>PhysicalLayer</Name>

<Desc>RS232 , RS485 , RS422 ,TCP</Desc>

<Value>RS232</Value>

</Node>

PhysicalLayer : Physical layer . for Modbus RTU select one of RS232, RS485 or RS422 for ModbusTCP Select TCP

<Node>

<Name>Protocol</Name>

<Desc>RTU,ASCII</Desc>

<Value>RTU</Value>

</Node>

Protocol : Modbus RTU or ASCII . This version supports RTU Only.

<Node>

<Name>COMPort</Name>

<Desc>Serial Port for Communication 1,2,3,4,5,...</Desc>

<Value>1</Value>

</Node>

COMPort : Serial Com Port for ModbsuRTU

```
<Node>
    <Name>BaudRate</Name>
    <Desc>9600,19200,36400,52700,115200</Desc>
    <Value>9600</Value>
</Node>
```

BaudRate : Modbus RTU Baudate for communication .

```
<Node>
    <Name>DataBit</Name>
    <Desc>7,8</Desc>
    <Value>8</Value>
</Node>
```

DataBit : ModbusRTU Data Bits . 7 or 8

```
<Node>
    <Name>StopBit</Name>
    <Desc>1,2</Desc>
    <Value>1</Value>
</Node>
```

StopBit : ModbusRTU Stop Bit .

```
<Node>
    <Name>Parity</Name>
    <Desc>None,Even,Odd</Desc>
    <Value>None</Value>
</Node>
```

Parity : Modbus RTU Parity Communication

```
<Node>
    <Name>SlaveAddress</Name>
    <Desc>SlaveAddress</Desc>
    <Value>3</Value>
</Node>
```

SlaveAddress: Modbus RTU/TCP slave ID

<Node>

<Name>FlowControl</Name>

<Desc>NO_FLOW_CONTROL,HW_FLOW_CONTROL,SW_FLOW_CONTROL</Desc>

<Value>NO_FLOW_CONTROL</Value>

</Node>

FlowControl: Flow Control for ModbusRTU

<Node>

<Name>PhysicalLayerScanTime</Name>

<Desc>PhysicalLayerScanTime</Desc>

<Value>100</Value>

</Node>

PhysicalLayerScanTime : Modbus Slave Driver will read Serial or TCP port every PhysicalLayerScanTime msec . if master request is large (like Writing many Modbus Signals , it is better to increase this value . 100 msec is optimized for may applications .

<Node>

<Name>Instance</Name>

<Desc>Instance</Desc>

<Value>1</Value>

</Node>

Instance : If you have many ModbusSlave Driver on a controller , each one must has unique Instance number .(maximum 8)

<Node>

<Name>TCPPort</Name>

<Desc>TCPPort</Desc>

<Value>502</Value>

</Node>

TCPPort : ModbusTCP Communication port . Default value is 502

<Node>

<Name>ShiftAddress</Name>

<Desc>ShiftAddress</Desc>

<Value>0</Value>

</Node>

Shift Address : this value with add to all Modbus Slave Address that is request from master .

Modbustags.xml file: in following figure you can see typical Modbus Slave Tags that is generate by pbsSoftLogic when you make a new Modbus Slave Driver.

ModbusTags - Notepad

File Edit Format View Help

```xml
<?xml version="1.0"?>
<OPCSrvTags>
     <Version>1.0.0</Version>
     <Tag Name="DITag1" Type="DI" Init="0" Address="1" Log="0" />
     <Tag Name="DITag2" Type="DI" Init="0" Address="2" Log="0" />
     <Tag Name="DITag3" Type="DI" Init="0" Address="3" Log="0" />
     <Tag Name="DITag4" Type="DI" Init="0" Address="4" Log="0" />
     <Tag Name="DITag5" Type="DI" Init="0" Address="5" Log="0" />
     <Tag Name="DITag6" Type="DI" Init="0" Address="6" Log="0" />
     <Tag Name="DITag7" Type="DI" Init="0" Address="7" Log="0" />
     <Tag Name="DITag8" Type="DI" Init="0" Address="8" Log="0" />

     <Tag Name="AITag1" Type="AI" Init="0" Address="1" Log="0" />
     <Tag Name="AITag2" Type="AI" Init="0" Address="2" Log="0" />
     <Tag Name="AITag3" Type="AI" Init="0" Address="3" Log="0" />
     <Tag Name="AITag4" Type="AI" Init="0" Address="4" Log="0" />
     <Tag Name="AITag5" Type="AI" Init="0" Address="5" Log="0" />
     <Tag Name="AITag6" Type="AI" Init="0" Address="6" Log="0" />
     <Tag Name="AITag7" Type="AI" Init="0" Address="7" Log="0" />
     <Tag Name="AITag8" Type="AI" Init="0" Address="8" Log="0" />

     <Tag Name="DOTag1" Type="DO" Init="0" Address="1" Log="0" />
     <Tag Name="DOTag2" Type="DO" Init="0" Address="2" Log="0" />
     <Tag Name="DOTag3" Type="DO" Init="0" Address="3" Log="0" />
     <Tag Name="DOTag4" Type="DO" Init="0" Address="4" Log="0" />
     <Tag Name="DOTag5" Type="DO" Init="0" Address="5" Log="0" />
     <Tag Name="DOTag6" Type="DO" Init="0" Address="6" Log="0" />
     <Tag Name="DOTag7" Type="DO" Init="0" Address="7" Log="0" />
     <Tag Name="DOTag8" Type="DO" Init="0" Address="8" Log="0" />

     <Tag Name="AOTag1" Type="AO" Init="0" Address="1" Log="0" />
     <Tag Name="AOTag2" Type="AO" Init="0" Address="2" Log="0" />
     <Tag Name="AOTag3" Type="AO" Init="0" Address="3" Log="0" />
     <Tag Name="AOTag4" Type="AO" Init="0" Address="4" Log="0" />
     <Tag Name="AOTag5" Type="AO" Init="0" Address="5" Log="0" />
     <Tag Name="AOTag6" Type="AO" Init="0" Address="6" Log="0" />
     <Tag Name="AOTag7" Type="AO" Init="0" Address="7" Log="0" />
     <Tag Name="AOTag8" Type="AO" Init="0" Address="8" Log="0" />
</OPCSrvTags>
```

Each Modbus Tag has following properties:

Name: Unique Modbus Tag Name. pbsSoftLogic will read this names and you can use Tags name in your logic .

Type: Tag Type (all Input Types must be writing in logic and all Output types must read in logic)

Input Types :

DI: Digital input.

AI : Analog input

FI : Floating point Input . In AI Space , will take 2 Address (Register)

INTI : Long input . In AI Space , will take 2 Address (Register)

INTUI : unsigned long . In AI Space , will take 2 Address (Register)

SFI : Swap Floating point Input . In AI Space , will take 2 Address (Register)

SINTI : Swap Long input . In AI Space , will take 2 Address (Register)

SINTUI : Swap unsigned long . In AI Space , will take 2 Address (Register)

Output Types :

DO: Digital Output.

AO : Analog Output

FO : Floating point Output. In AO Space , will take 2 Address (Register)

INTO : Long Output. In AO Space , will take 2 Address (Register)

INTUO : unsigned long . In AO Space , will take 2 Address (Register)

SFO : Swap Floating point Output. In AO Space , will take 2 Address (Register)

SINTO : Swap Long Output. In AO Space , will take 2 Address (Register)

SINTUO : Swap unsigned long . In AO Space , will take 2 Address (Register)

Init: init value of Modbus Slave Tag

Address: Modbus Slave Tag Address.

Log : If Log value is 1 , Driver will always used latest value of Modbus tag not Init Value . Suppose you define a set point with init value of 10 . If Modbus Master change this value to 12.0 and you restart controller, Modbus Slave Driver will use 12 as init value of Tag .

Note 1 :This facility is just works for AO , DO and FO Tags . (Modbus Slave Output tgs)

Note 2 : Runtime kernel in Controller will check every min for Modbus Slave changes and will copy changes to internal flash memory . so if you change set points by Modbus master and restart controller before one min pass , then controller is not keeping last value of set points .

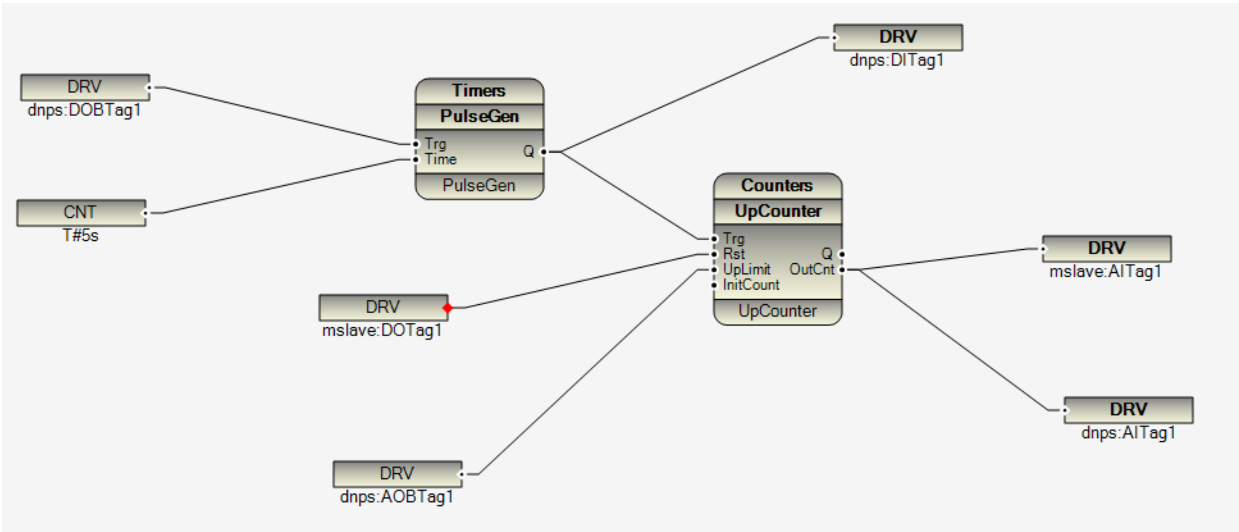
Modbus Slave Driver operation:

1-Modbus master is reading all Input Tags (DI, AI, FI,…) by polling.

You should write on all Modbus Slave Input Signal on your logic . (Connect to FB output ports)

2 - Modbus master is writing all output signals (DO, AO, FO, ..) .

You should read output tags in your logic. (Connect to FB input ports)



In above sample logic mslave:DOTag1 is an output signal from Modbus master (Linked to FB input port) and mslave:AiTag1 is an input signal to modbus master (Linked to FB output ports)

There is a new SYS type signal in Modbus Slave Tags which is automatically define by pbsSoftLogic .

```
<Tag Name="MasterOnline" Type="SYS" Init="0" Address="0" Log="0" />
<Tag Name="DITag0" Type="DI" Init="0" Address="0" Log="0" />
<Tag Name="DITag1" Type="DI" Init="0" Address="1" Log="0" />
```

MasterOnLine Signal Shows Master is connected to Slave Driver or not. If Master is sending proper Message to Slave Driver and getting Answer from Driver , MasterOnLine Will set to 1 , otherwise it will set to 0 .

Important Point about **PhysicalLayerScanTime**

In Some projects that DCS is operating as Modbus Master and pbsSoftLogic is working as Modbus Slave , Because DCS is writing all signals mostly as Holding Register into Slave , Modbus Frame length from DCS side is not small so you need to increase PhysicalLayerScanTime to accept DCS Modbus Frame . Otherwise RTU is not communication with DCS .

8 – DNP3 Slave Configuration

pbsSoftlogic supports DNP3 slave driver. Please refer to www.dnp.org web site for detail information about DNP3 protocol.

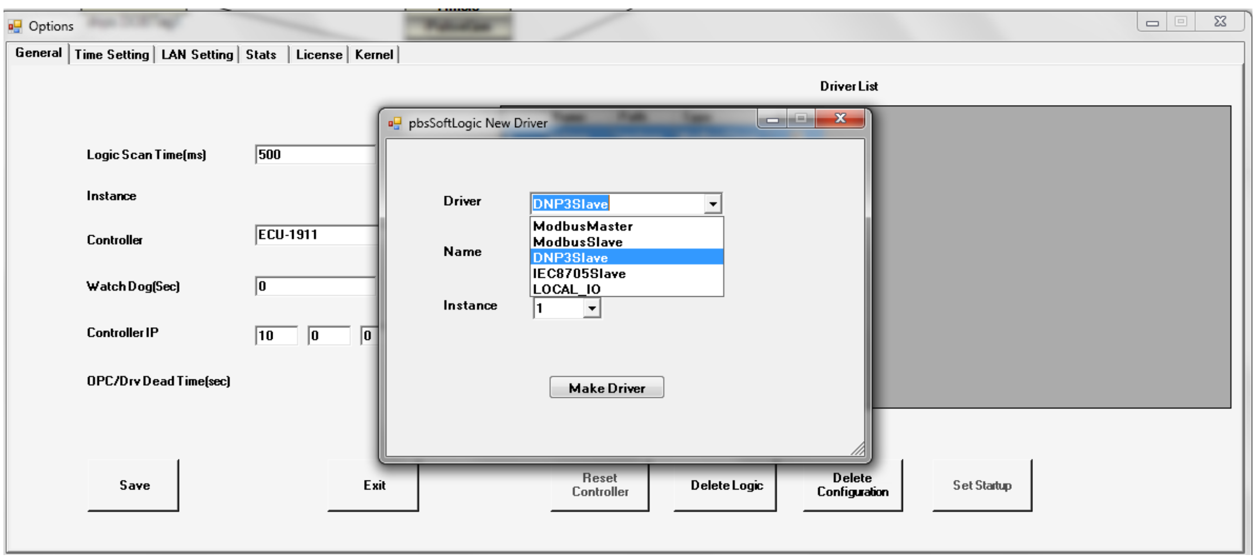
You can define up to 4 dnp3 slave instances for a controller. Each DNP3 slave instance can be connected to separate DNP3 master SCADA.

At each instance you can define 1024 DNP tags .

As physical layer you can select RS232 and TCP/IP.

Defining new DNP3 slave driver:

- Open project setting
- Right click on driver list
- Select New Driver
- Select DNP3Slave as Driver type
- Type a unique name for Driver name
- Select unique Instance for driver



- Click on make driver button .

pbsSoftLogic will make option file and DNP3 Slave tags files and will make a new directory with the same name of Driver name in logic path .

- Options.xml define communication parameters
- DNP3Tags.xml define dnp3 tags

Options.xml parameters:

<Node>

<Name>PhysicalLayer</Name>

<Desc>RS232 , TCP</Desc>

<Value>TCP</Value>

</Node>

You can select physical layer between RS232 and TCP.

<Node>

<Name>COMPort</Name>

<Desc>Serial Port for Communication 1,2,3,4,5,...</Desc>

<Value>2</Value>

</Node>

Controller Serial port for RS232 Communication.

<Node>

<Name>BaudRate</Name>

<Desc>9600,19200,36400,52700,115200</Desc>

<Value>19200</Value>

</Node>

Communication baud rate

<Node>

<Name>SlaveAddress</Name>

<Desc>SlaveAddress</Desc>

<Value>3</Value>

</Node>

RTU DNP3 Address

```
<Node>
    <Name>MasterIPAddress</Name>
    <Desc>MasterIPAddress</Desc>
    <Value>10.0.0.11</Value>
</Node>
```

DNP3 master SCADA IP address

```
<Node>
    <Name>TCPIPPort</Name>
    <Desc>TCPIPPort</Desc>
    <Value>20000</Value>
</Node>
```

TCP Port for using in TCP Connection , by default it is 20000

```
<Node>
    <Name>MasterAddress</Name>
    <Desc>MasterAddress</Desc>
    <Value>1</Value>
</Node>
```

DNP3 Master SCADA Address

```
<Node>
    <Name>LocalIPAddress</Name>
    <Desc>LocalIPAddress</Desc>
    <Value>10.0.0.10</Value>
</Node>
```

Controller LAN Port for communication with master SCADA

```
<Node>
    <Name>PhysicalLayerScanTime</Name>
    <Desc>PhysicalLayerScanTime</Desc>
    <Value>100</Value>
</Node>


<Node>
    <Name>Instance</Name>
    <Desc>Instance</Desc>
    <Value>1</Value>
</Node>
```

Driver instance number 1 ,2,3,4

```
<Node>
    <Name>TCPIPMode</Name>
    <Desc>0 = TCP Listening End Point ,  1= UDP endpoint ,  2 = TCP Dual End Point</Desc>
    <Value>0</Value>
</Node>
<Node>
    <Name>AppFrameSize</Name>
    <Desc>AppFrameSize</Desc>
    <Value>2000</Value>
</Node>
```

<Node>

<Name>SBOTimeOut</Name>

<Desc>SBOTimeOut(Sec)</Desc>

<Value>10</Value>

</Node>

Select before Operate delay

<Node>

<Name>NoCommTimeout</Name>

<Desc>NoCommTimeout(Sec)</Desc>

<Value>0</Value>

</Node>

Time that RTU is checking communication, if there is no any communication in this period, RTU will close connection in TCP Mode. 0 means communication checking is disabling. Unit is in second.

DNP3Tags.xml

When you make a new driver, pbsSoftLogic will make a default DNP3 Tags file. You can edit this file and add or remove tags.

Name: Tag Name. It should be unique in your Logic.

Type: DNP3 Tag Type. We support following types:

- DI : Digital input Read By Master with different variations , DNP Group1 , 2
- AI : Analog input Read By Master with different variations , DNP Group 30,31,32,33
- CNT : Counter Read By Master with different variations DNP Group 20,21,22,23
- FI : Float Input : DNP Group 100
- DOB : Digital Output Block Write by master with different mode DNP Group 12 ,13
- AOB : Analog Output Block Write by master with different mode , DNP Group 41
- DO : DO Status Read By Master with different variations , DNP Group 10,11
- AO : AO Status Read By Master with different variations , DNP Group 40
- DPI : Double Bit Binary Read By Master with different variations , DNP Group 3,4

Class : Based on DNP3 Standard we have class 0 ,1,2,3,4

Class 0 means current value of tags without event buffering . So if you put class 0 for a tag, RTU is not buffering tag changes and every time master read tag , RTU will send current value .

Class 1,2,3,4 there is no different or priority between different classes. So if you put class 1,2,3 or 4 for a tag RTU will buffer all tag changes with time and will report to Master SCADA .

There is a cyclic buffer with 10,000 events for each DNP Type in RTU.

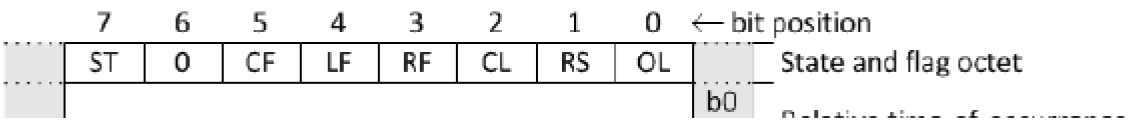
Address: DNP3 tag address. AI and FI are using same address range.

Log : When set to 1 for DOB and AOB Tags , RTU will keep last value of Set Point in internal memory flash and if you restart RTU , it will use latest set points from Master SCADA . RTU will check AOB and DOB changes every min and if it detect changes, it will save them on internal flash memory.

Init : Init Value of a tag .

```
<Tag Name="AITag7" Type="AI" Class="1" Init="0" Address="7" Log="0" />
<Tag Name="AITag8" Type="AI" Class="1" Init="0" Address="8" Log="0" />
<Tag Name="CNTTag1" Type="CNT" Class="1" Init="0" Address="1" Log="0" />
<Tag Name="CNTTag2" Type="CNT" Class="1" Init="0" Address="2" Log="0" />
<Tag Name="CNTTag3" Type="CNT" Class="1" Init="0" Address="3" Log="0" />
<Tag Name="CNTTag4" Type="CNT" Class="1" Init="0" Address="4" Log="0" />
<Tag Name="CNTTag5" Type="CNT" Class="1" Init="0" Address="5" Log="0" />
<Tag Name="CNTTag6" Type="CNT" Class="1" Init="0" Address="6" Log="0" />
```

Tag Flag: Based on DNP3 Standard, DNP3 Data Types has Flag Status with following definition.



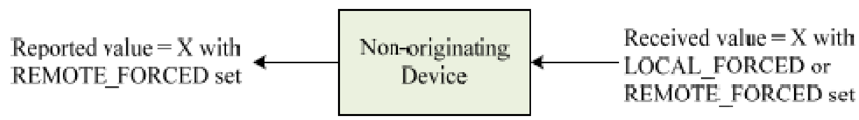
Name	Functional description
ONLINE	For input data objects: If clear, the point is inactive or disabled (for example: powered-down, faulty, etc.) and unable to obtain field data. The flag may optionally be cleared by a non-originating device if communications to the originating device fail. In this case the COMM_LOST flag shall also be set. For output status objects: If clear, the output point is inactive, unavailable, out-of-service, not installed, or operating in local mode. The point may not be observable or may be not controllable. Commands sent to the point may fail. When an output point is in local mode, it shall clear this flag.

Name	Functional description
RESTART	The RESTART flag indicates that the data has not been updated from the field since device reset. Originating devices shall set this bit immediately upon restarting and keep the bit set until they have an updated value in their database. Non-originating devices shall set this bit immediately upon restart and keep the bit set until it is overwritten by collecting data from a reporting device. For input data objects:If set, the object is in the initialization state, having a value that has never been updated from the field since restart. The bit is cleared when the object is first updated. In an originating device, this is when the field value is first acquired. In a non-originating device, the bit remains set until it is overwritten by collecting data from a reporting device and that data does not have the RESTART flag set. For output status objects: The RESTART flag shall only be set while a device is restarting. In an originating device, the flag shall be cleared after the device is available to accept commands, irrespective of whether or not an output value (control) has been sent to the output object. In a non-originating device, the bit remains set until it is overwritten by collecting output status information from a reporting device and that data does not have the RESTART flag set.
COMM_LOST	COMM_LOST indicates that there is a communication failure in the path between the device where the data originates and the reporting device. This flag indicates that the value reported for the object may be stale. If set, the data value reported shall be the last value available from the originating device before communications were lost. An originating device never sets this flag. A non-originating device sets this flag if it loses communication with the adjacent downstream device; otherwise it propagates the state of COMM_LOST flag as received from the downstream device. Once set, this flag may only be cleared when data for this point is received from the adjacent downstream device and the COMM_LOST flag received with that data is cleared.

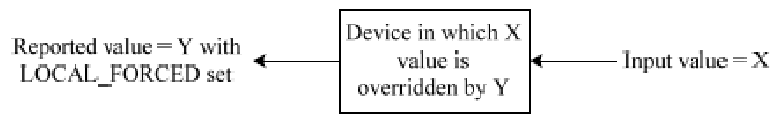
<table>
<tr><td>REMOTE_FORCED</td><td>If set, the data value is overridden in a downstream reporting device.

Only a non-originating device may set this flag. The flag is set when an overridden value is received. The REMOTE_FORCED flag shall be set in an object if either the REMOTE_FORCED or LOCAL_FORCED flags (see below) are set in an object received from a downstream device.

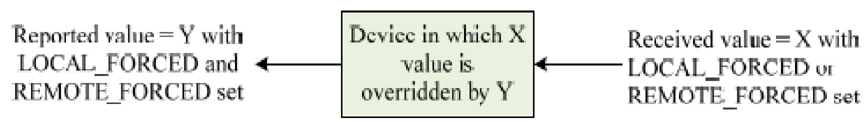
An originating device may never set this bit.



See flag description 11.6.1.1, NOTE 3.</td></tr>
<tr><td>LOCAL_FORCED</td><td>If set, the data value is overridden by the device that reports this flag as set. This may be due to the device operating in a diagnostic or temporary mode or due to human intervention.



If the value is forced in a non-originating device and overridden in a downstream device, then the non-originating device shall set both REMOTE_FORCED and LOCAL_FORCED flags.



See flag description 11.6.1.1, NOTE 3.</td></tr>
</table>

CHATTER_FILTER	Only applicable to single-bit binary input and double-bit binary input object groups. If set, the binary data value is presently changing between states at a sufficiently high enough rate to activate a chatter filter. The binary data value reported does not necessarily represent the actual state because the chatter filter may clamp the reported value to a single state during the time it is active. The purpose of the chatter filter is to suppress event reporting for binary and double-bit binary inputs that are experiencing a rapid series of state changes. The determination of what constitutes "chattering" is device-dependent. While a binary input is chattering, the originating device shall set the CHATTER_FILTER flag. When the chattering input again becomes stable, the originating device shall clear the flag and report the current state of the input. The CHATTER_FILTER bit indicates that the binary input point has been filtered in order to remove unneeded transitions in the state of the point. Events are generated when the CHATTER_FILTER flag is set and cleared.
ROLLOVER	Only applicable to counter object groups. This flag is obsolete and should not be set in new designs. Information is presented here for historical reasons. There is no mechanism within DNP3 for the outstation to report the value at which counter rollover occurs (i.e., the maximum possible counter value). Hence outstations shall not set the ROLLOVER flag and master devices shall ignore the ROLLOVER flag. If polled data reporting is used, the master is responsible for polling counter data frequently enough to detect rollover.
OVER_RANGE	Only applicable to analog input and analog output object groups. If set, the data object's true value exceeds the valid measurement range of the object. See flag description 11.6.1.1, NOTE 4, for more details.

State Flag for Digital signals:

7	6	5	4	3	2	1	0	← bit position
ST	0	CF	LF	RF	CL	RS	OL	State and flag octet

A.2.2.2.2 Formal structure

BSTR8: Flag Octet

Bit 0: ONLINE

Bit 1: RESTART

Bit 2: COMM_LOST

Bit 3: REMOTE_FORCED

Bit 4: LOCAL_FORCED

Bit 5: CHATTER_FILTER

Bit 6: Reserved, always 0

Bit 7: STATE—Has a value of 0 or 1, representing the state of the physical or logical input.

State Tag for Double Bit signals :

7	6	5	4	3	2	1	0	← bit position
ST		CF	LF	RF	CL	RS	OL	State and flag octet

A.4.2.2.2 Formal structure

BSTR6: Flags

Bit 0: ONLINE

Bit 1: RESTART

Bit 2: COMM_LOST

Bit 3: REMOTE_FORCED

Bit 4: LOCAL_FORCED

Bit 5: CHATTER_FILTER

UINT2: State.

This integer contains the state of the double-bit binary input as defined for a Double-bit Binary Input Point Type in 11.9.6. These values represent states INTERMEDIATE, DETERMINED_OFF, DETERMINED_ON, and INDETERMINATE.

State Flag for DO Signals :

Bit 0: ONLINE

Bit 1: RESTART

Bit 2: COMM_LOST

Bit 3: REMOTE_FORCED

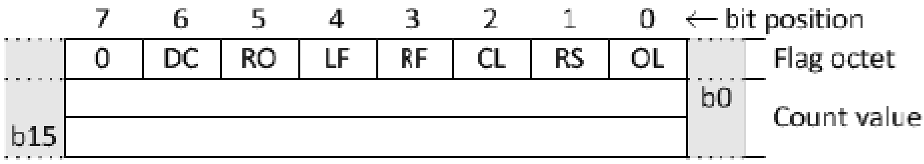
Bit 4: LOCAL_FORCED

Bit 5: Reserved, always 0

Bit 6: Reserved, always 0

Bit 7: STATE—Value is 1 or 0, where 1 indicates that the output signal is active and 0 indicates that the output signal is not active. Where the output object does not have a meaningful output state, the STATE flag shall be 0.

State Flag for Counters :

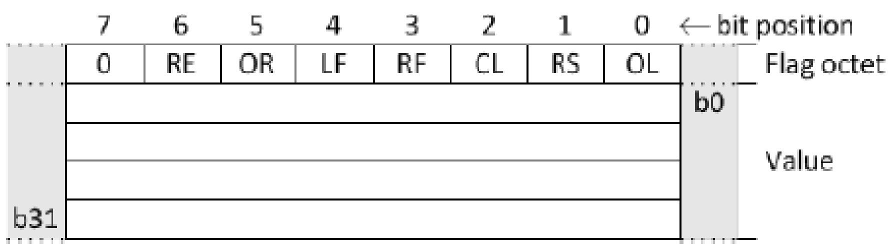


A.10.2.2.2 Formal structure

BSTR8: Flag Octet

Bit 0:	ONLINE
Bit 1:	RESTART
Bit 2:	COMM_LOST
Bit 3:	REMOTE_FORCED
Bit 4:	LOCAL_FORCED
Bit 5:	ROLLOVER
Bit 6:	DISCONTINUITY
Bit 7:	Reserved, always 0.

State Flag for AI :

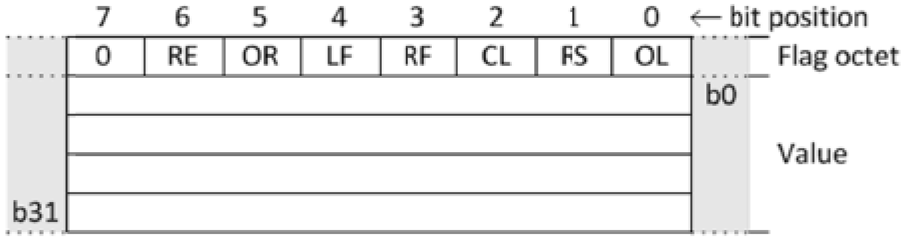


A.14.1.2.2 Formal structure

BSTR8: Flag Octet

Bit 0:	ONLINE
Bit 1:	RESTART
Bit 2:	COMM_LOST
Bit 3:	REMOTE_FORCED
Bit 4:	LOCAL_FORCED
Bit 5:	OVER_RANGE
Bit 6:	REFERENCE_ERR
Bit 7:	Reserved, always 0.

State Flag for AO :



A.19.1.2.2 Formal structure

BSTR8: Flag Octet

Bit 0:	ONLINE
Bit 1:	RESTART
Bit 2:	COMM_LOST
Bit 3:	REMOTE_FORCED
Bit 4:	LOCAL_FORCED
Bit 5:	OVER_RANGE
Bit 6:	REFERENCE_ERR
Bit 7:	Reserved, always 0.

You can set DNP3 Flags to DNP3 Driver by defining Status Tags.

DIS, AIS, FIA, DPIS, CNTS, DOS, AOS are data types for Status flag.

For Tags that you want to define Status Tag, you need to define a new tag with Data type changed to Status Type and with new Name. Other Parameters are no changed. It should define exactly after Main Tag. Look at following examples:

<Tag Name="DITag1" Type="DI" Class="1" Init="0" Address="1" Log="0" />

<Tag Name="DITag1.s" Type="DIs" Class="1" Init="0" Address="1" Log="0" />

<Tag Name="AITag1" Type="AI" Class="1" Init="0" Address="1" Log="0" />

<Tag Name="AITag1.s" Type="AIS" Class="1" Init="0" Address="1" Log="0" />

<Tag Name="FITag1" Type="FI" Class="1" Init="0" Address="1" Log="0" />

<Tag Name="FITag1.s" Type="FIS" Class="1" Init="0" Address="1" Log="0" />

<Tag Name="CNTTag1" Type="CNT" Class="1" Init="0" Address="1" Log="0" />

<Tag Name="CNTTag1.s" Type="CNTS" Class="1" Init="0" Address="1" Log="0" />

<Tag Name="DOTag1" Type="DO" Class="1" Init="0" Address="1" Log="0" />

<Tag Name="DOTag1.s" Type="DOS" Class="1" Init="0" Address="1" Log="0" />

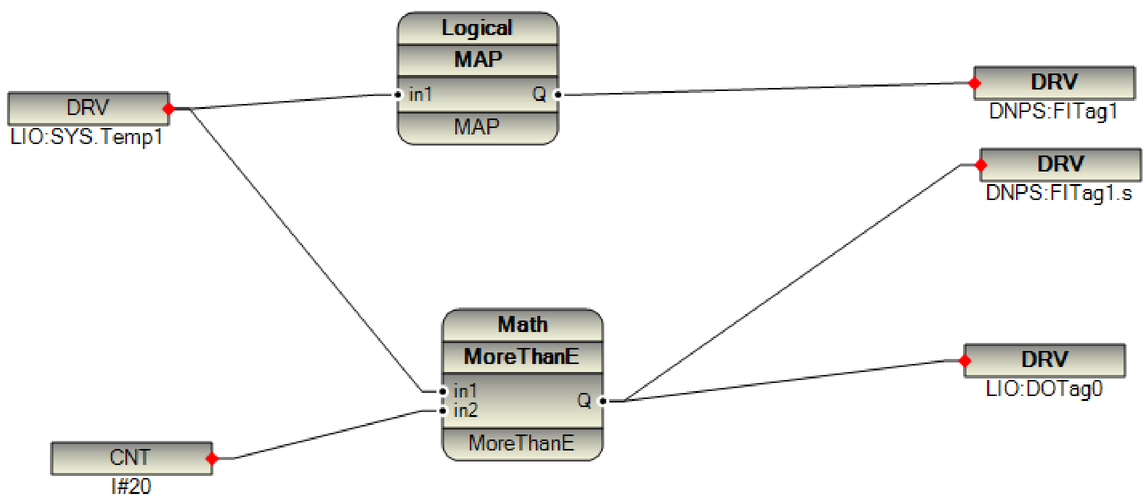
<Tag Name="AOTag1" Type="AO" Class="1" Init="0" Address="1" Log="0" />

<Tag Name="AOTag1.s" Type="AOs" Class="1" Init="0" Address="1" Log="0" />

For Tags without Status Tag , psle consider Tag always Online .

For Tags with Status Tag defined, you need to pass 1 for online and 0 for Offline Status of Tag in your logic.

Look at following sample: When Temperature is more than 20 deg, then FITag1 Status is Online and valid. Otherwise it is Offline.



Example 2: suppose you connect COM3 of pbs2008RTU to Power meter by Modbus Master. Then you can link online status of DNP3 Tags for power meter to Modbus SYS.Online Tag.

So in Master SCADA when there is no communication between RTU and Power meter, it will show Tag Offline.

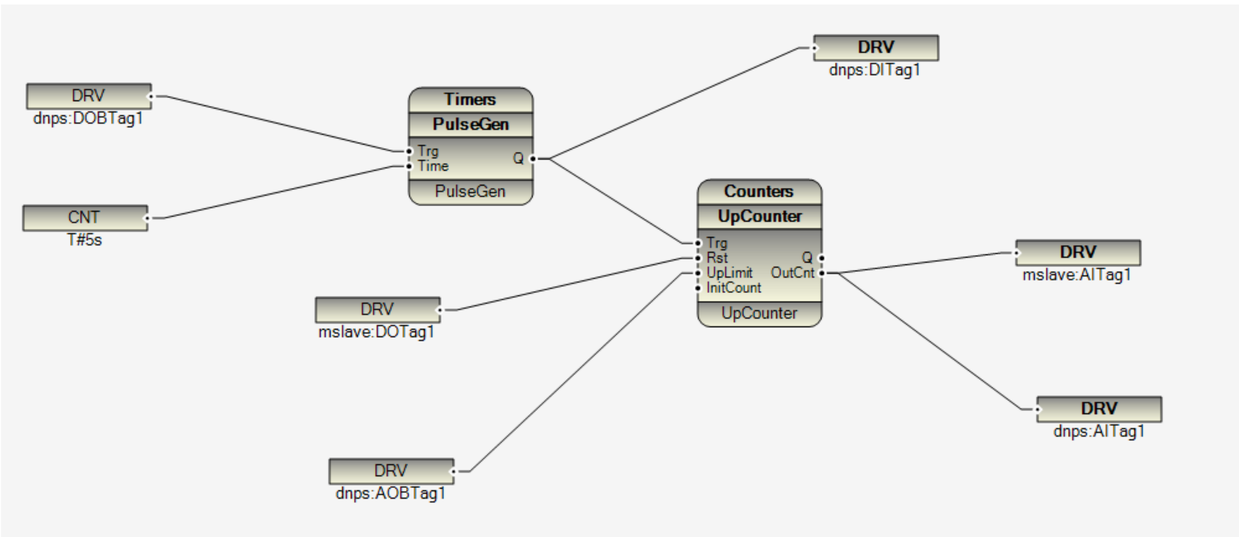
DNP3 Slave driver Operation:

1 - Master SCADA will read all Input Signals (DI , AI , FI , DO , AO , DPI)

- You need to write all Input Signals in your logic.(Link to FB right ports)

2 – Master SCADA will write Output Signals (DOB , AOB)

- You need to read all Output Tags in your logic (Link to FB left Ports)



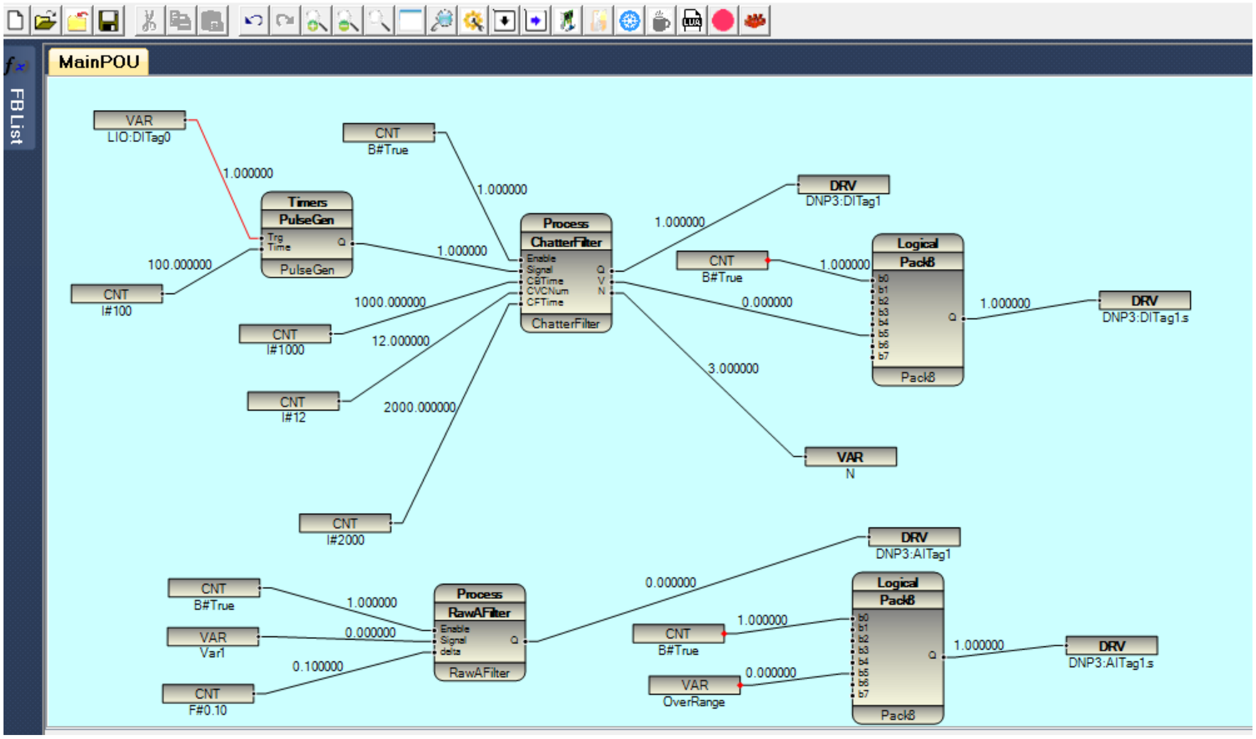
In above logic we have following DNPs signals:

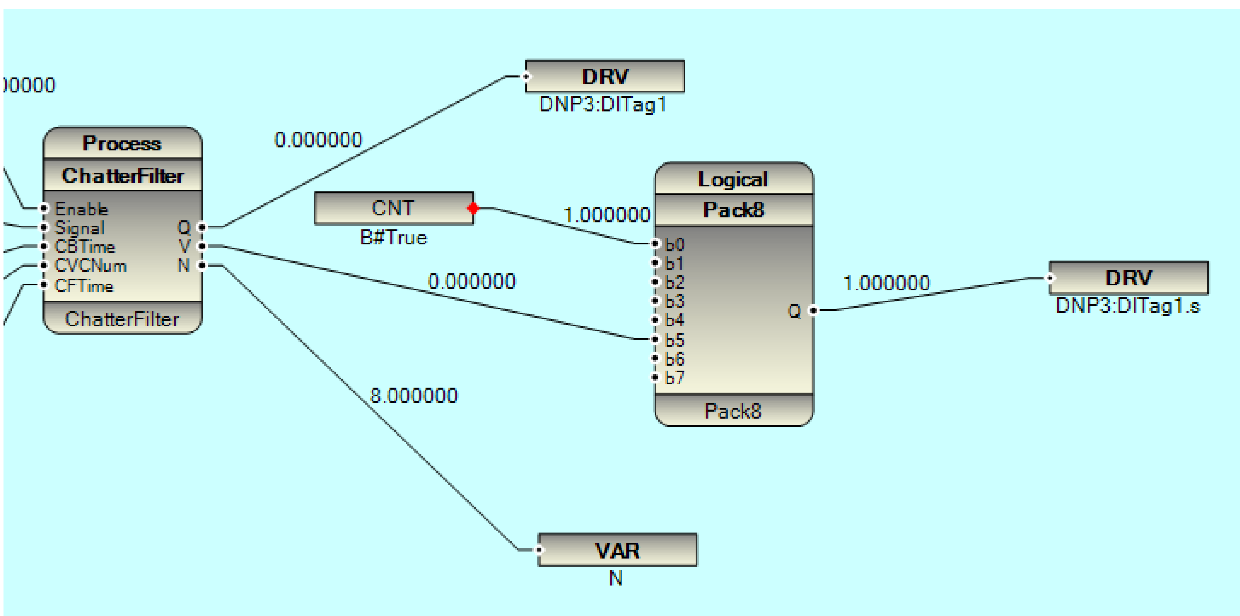
- Dnps: DOBTag1 is a DOB signal which is written by DNP Master.
- dnps:DITag1 is a Di signal which is read by DNP Master
- dnps:AOBTag1 : AOB signal (Analog Output) which is written by DNP Master
- dnps:AITag1 : AI (Analog input) Signal which is read by DNP Master

DNP3 function codes which are implemented:

- Read class 0,1,2,3,4
- Integrity command
- Read Event by exception (RBE)
- Time synchronization
- Enable /Disable unsolicited communications (Transfer data from RTU to Master SCADA)
- Dynamic Class assign
- Freezing counters
- Write

Sample Logic for handling State Flag for Digital and Analog Signals:





Test DNP3 driver with Kepware OPC Server

For testing DNP3 Driver you can use KepWare OPC Server. Please download KepWare OPC suite from www.kepware.com

Our sample configuration is as following. You can download it from www.pbscontrol.com/psleSample/dnp_Kepware.zip

DNP Type: TCP communication with port Number 20,000

Unsolicited communication: Automatic and Master is reading class1 events every 5 Sec

RTU Type: pbs2008RTU

RTU IP: 192.168.1.137

RTU DNP3 ID = 3

Master ID = 1

Master IP Address: 192.168.1.152

Keep Alive Timer in RTU (NoCommTimeout): 60 Sec , we will set Keep Alive time to 20 sec in master .

RTU DNP3 Tags as Following :

<Tag Name="MasterOnline" Type="SYS" Class="0" Init="0" Address="0" Log="0" />

<Tag Name="DITag1" Type="DI" Class="1" Init="0" Address="1" Log="0" />

<Tag Name="DITag2" Type="DI" Class="1" Init="0" Address="2" Log="0" />

<Tag Name="DITag3" Type="DI" Class="1" Init="0" Address="3" Log="0" />

<Tag Name="DITag4" Type="DI" Class="1" Init="0" Address="4" Log="0" />

<Tag Name="DITag5" Type="DI" Class="1" Init="0" Address="5" Log="0" />

<Tag Name="DITag6" Type="DI" Class="1" Init="0" Address="6" Log="0" />

<Tag Name="DITag7" Type="DI" Class="1" Init="0" Address="7" Log="0" />

<Tag Name="DITag8" Type="DI" Class="1" Init="0" Address="8" Log="0" />

<Tag Name="DITag9" Type="DI" Class="1" Init="0" Address="9" Log="0" />

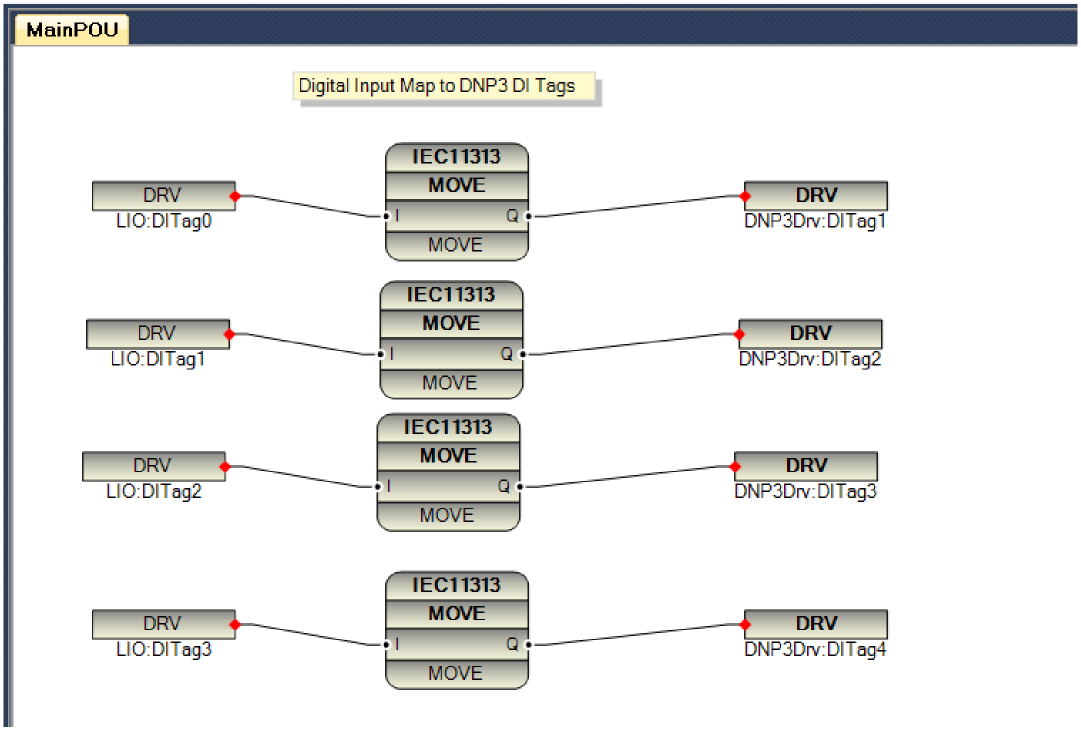
<Tag Name="DITag10" Type="DI" Class="1" Init="0" Address="10" Log="0" />

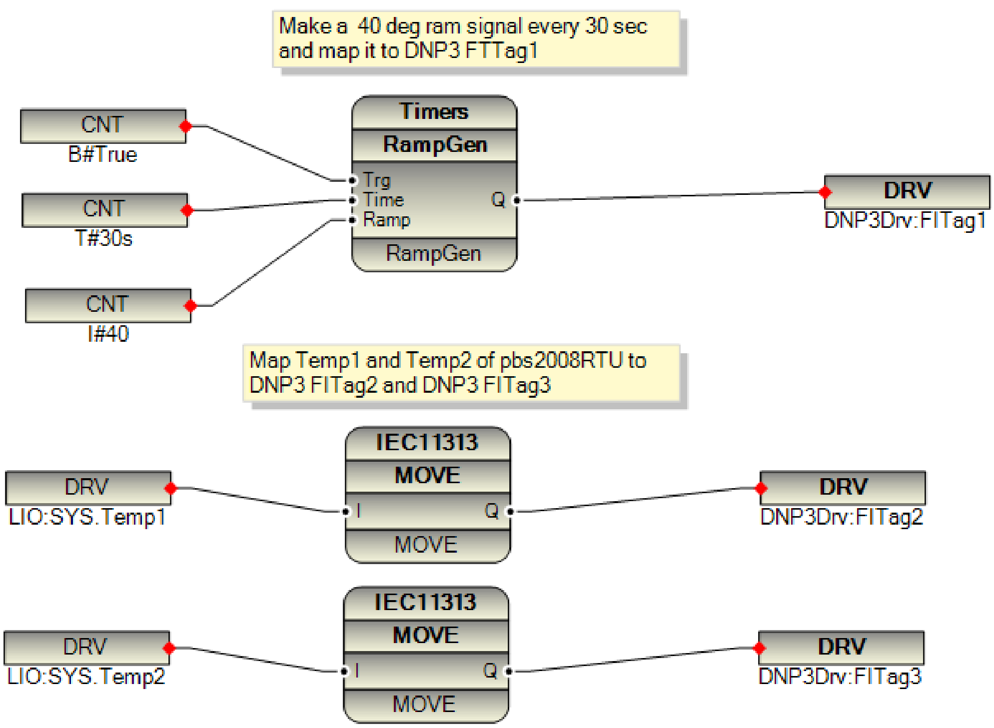
<Tag Name="AITag1" Type="AI" Class="1" Init="0" Address="1" Log="0" />

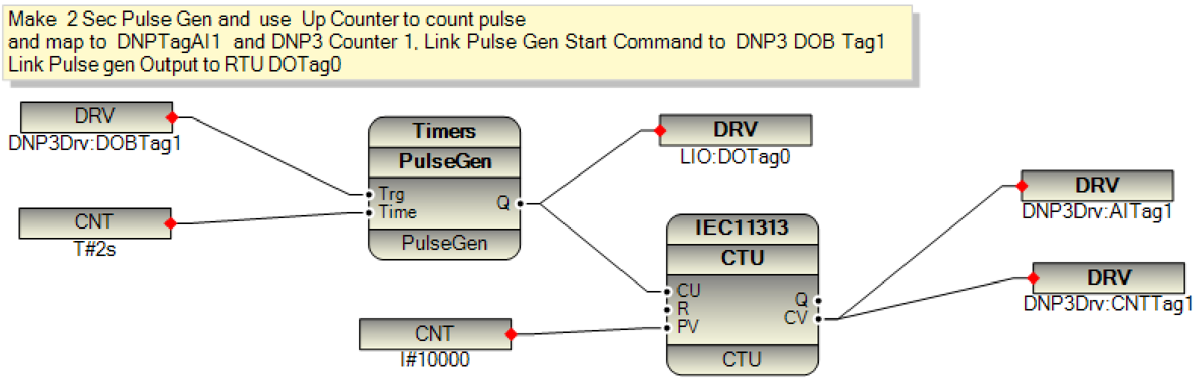
```
<Tag Name="AITag2" Type="AI" Class="1" Init="0" Address="2" Log="0" />
<Tag Name="AITag3" Type="AI" Class="1" Init="0" Address="3" Log="0" />
<Tag Name="AITag4" Type="AI" Class="1" Init="0" Address="4" Log="0" />
<Tag Name="AITag5" Type="AI" Class="1" Init="0" Address="5" Log="0" />
<Tag Name="AITag6" Type="AI" Class="1" Init="0" Address="6" Log="0" />
<Tag Name="AITag7" Type="AI" Class="1" Init="0" Address="7" Log="0" />
<Tag Name="AITag8" Type="AI" Class="1" Init="0" Address="8" Log="0" />
<Tag Name="AITag9" Type="AI" Class="1" Init="0" Address="9" Log="0" />
<Tag Name="AITag10" Type="AI" Class="1" Init="0" Address="10" Log="0" />
<Tag Name="FITag1" Type="FI" Class="1" Init="0" Address="11" Log="0" />
<Tag Name="FITag2" Type="FI" Class="1" Init="0" Address="12" Log="0" />
<Tag Name="FITag3" Type="FI" Class="1" Init="0" Address="13" Log="0" />
<Tag Name="FITag4" Type="FI" Class="1" Init="0" Address="14" Log="0" />
<Tag Name="FITag5" Type="FI" Class="1" Init="0" Address="15" Log="0" />
<Tag Name="FITag6" Type="FI" Class="1" Init="0" Address="16" Log="0" />
<Tag Name="FITag7" Type="FI" Class="1" Init="0" Address="17" Log="0" />
<Tag Name="FITag8" Type="FI" Class="1" Init="0" Address="18" Log="0" />
<Tag Name="FITag9" Type="FI" Class="1" Init="0" Address="19" Log="0" />
<Tag Name="FITag10" Type="FI" Class="1" Init="0" Address="20" Log="0" />
<Tag Name="CNTTag1" Type="CNT" Class="1" Init="0" Address="1" Log="0" />
<Tag Name="CNTTag2" Type="CNT" Class="1" Init="0" Address="2" Log="0" />
<Tag Name="CNTTag3" Type="CNT" Class="1" Init="0" Address="3" Log="0" />
<Tag Name="CNTTag4" Type="CNT" Class="1" Init="0" Address="4" Log="0" />
<Tag Name="CNTTag5" Type="CNT" Class="1" Init="0" Address="5" Log="0" />
<Tag Name="CNTTag6" Type="CNT" Class="1" Init="0" Address="6" Log="0" />
```

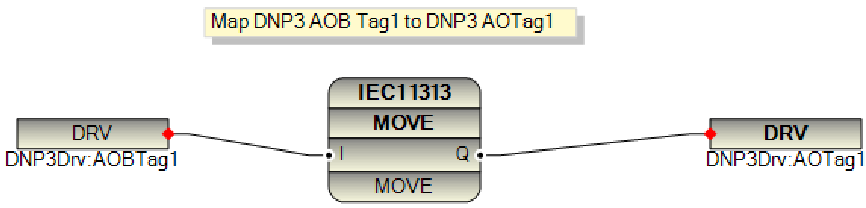
```xml
<Tag Name="CNTTag7" Type="CNT" Class="1" Init="0" Address="7" Log="0" />
<Tag Name="CNTTag8" Type="CNT" Class="1" Init="0" Address="8" Log="0" />
<Tag Name="CNTTag9" Type="CNT" Class="1" Init="0" Address="9" Log="0" />
<Tag Name="CNTTag10" Type="CNT" Class="1" Init="0" Address="10" Log="0" />
<Tag Name="DOBTag1" Type="DOB" Class="1" Init="0" Address="1" Log="0" />
<Tag Name="DOBTag2" Type="DOB" Class="1" Init="0" Address="2" Log="0" />
<Tag Name="DOBTag3" Type="DOB" Class="1" Init="0" Address="3" Log="0" />
<Tag Name="DOBTag4" Type="DOB" Class="1" Init="0" Address="4" Log="0" />
<Tag Name="DOBTag5" Type="DOB" Class="1" Init="0" Address="5" Log="0" />
<Tag Name="AOBTag1" Type="AOB" Class="1" Init="0" Address="1" Log="0" />
<Tag Name="AOBTag2" Type="AOB" Class="1" Init="0" Address="2" Log="0" />
<Tag Name="AOBTag3" Type="AOB" Class="1" Init="0" Address="3" Log="0" />
<Tag Name="AOBTag4" Type="AOB" Class="1" Init="0" Address="4" Log="0" />
<Tag Name="AOBTag5" Type="AOB" Class="1" Init="0" Address="5" Log="0" />
<Tag Name="DOTag1" Type="DO" Class="1" Init="0" Address="1" Log="0" />
<Tag Name="DOTag2" Type="DO" Class="1" Init="0" Address="2" Log="0" />
<Tag Name="DOTag3" Type="DO" Class="1" Init="0" Address="3" Log="0" />
<Tag Name="DOTag4" Type="DO" Class="1" Init="0" Address="4" Log="0" />
<Tag Name="DOTag5" Type="DO" Class="1" Init="0" Address="5" Log="0" />
<Tag Name="AOTag1" Type="AO" Class="1" Init="0" Address="1" Log="0" />
<Tag Name="AOTag2" Type="AO" Class="1" Init="0" Address="2" Log="0" />
<Tag Name="AOTag3" Type="AO" Class="1" Init="0" Address="3" Log="0" />
<Tag Name="AOTag4" Type="AO" Class="1" Init="0" Address="4" Log="0" />
<Tag Name="AOTag5" Type="AO" Class="1" Init="0" Address="5" Log="0" />
```

Develop RTU logic as following:

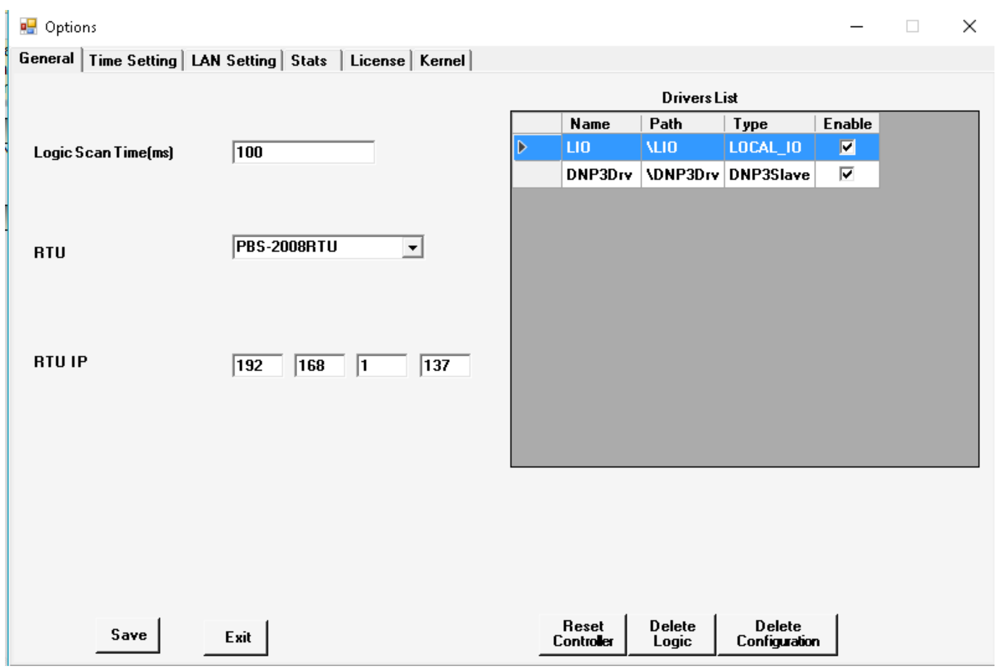






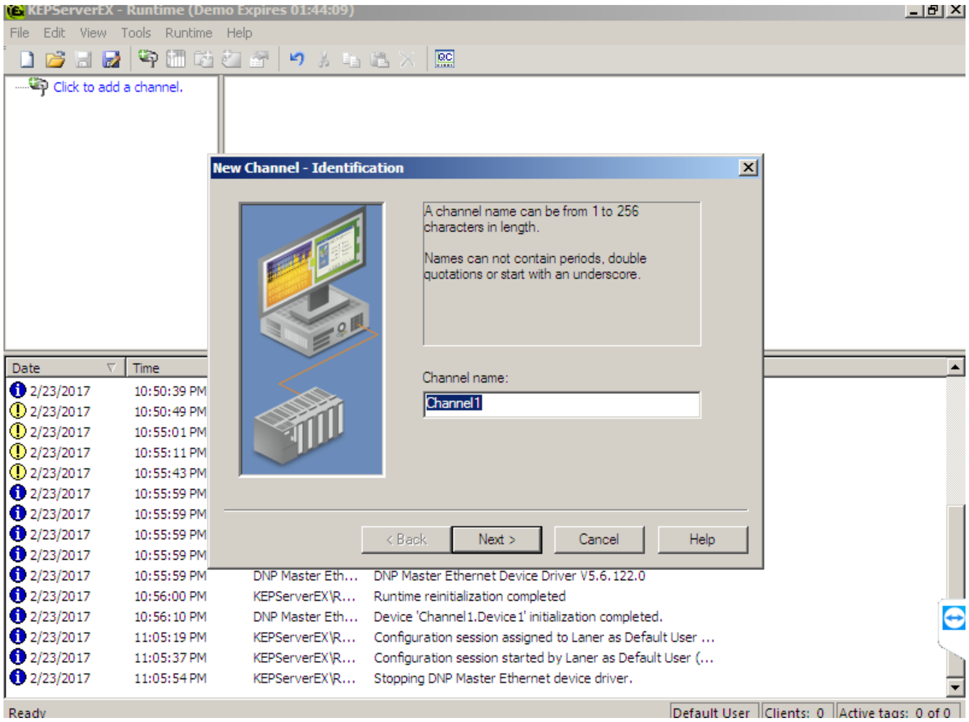


RTU Driver Configuration: Define one Local IO and one DNP3 Slave Driver.

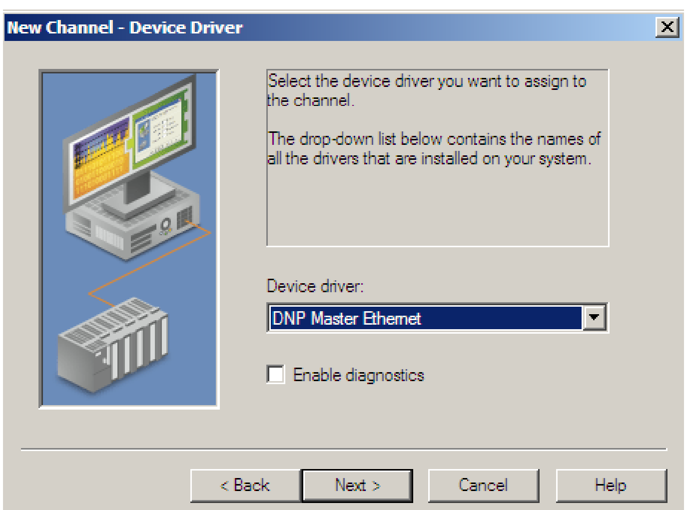


Step 1 : run Kepware Configurator Software

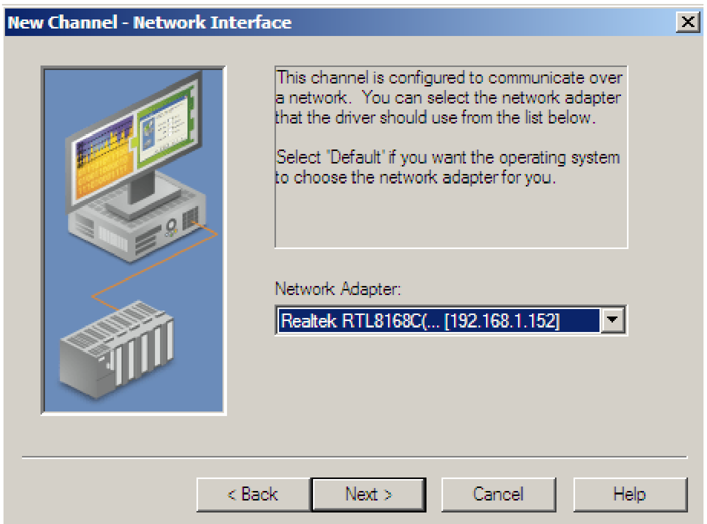
Step 2 : Add new communication channel to configuration



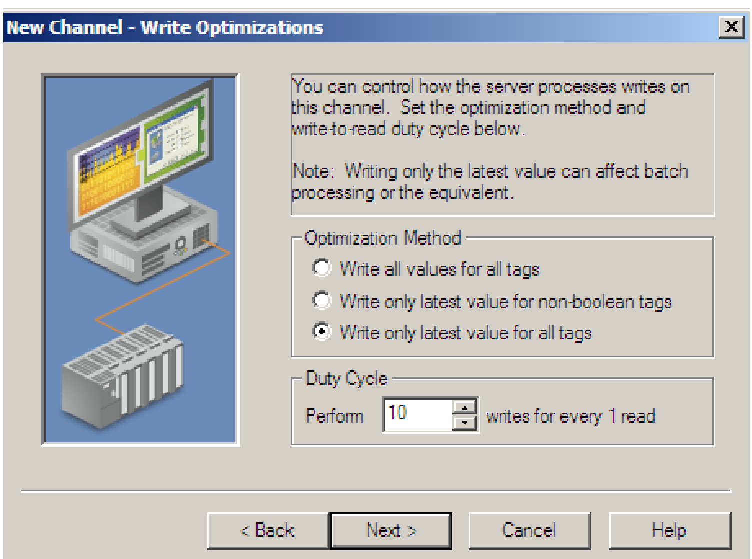
Step 3 – Select “DNP Master Ethernet” to communicate with RTU with DNP3 over TCP connection.



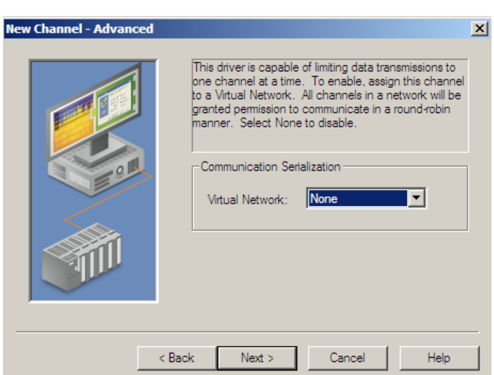
Step 4 : Select your PC Ethernet card



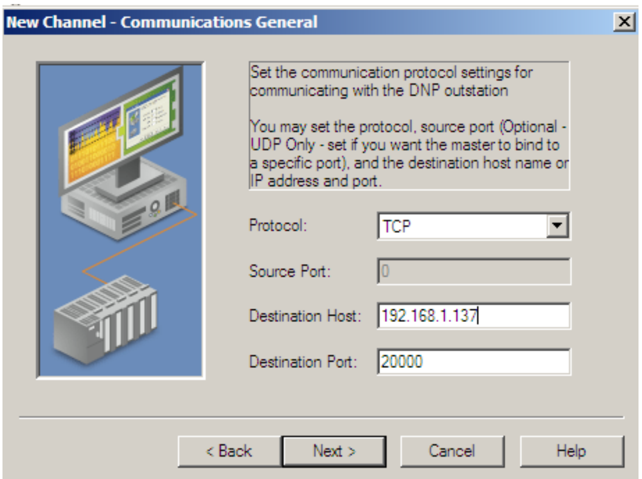
Step 5 : Select default options in Write Optimization parameters



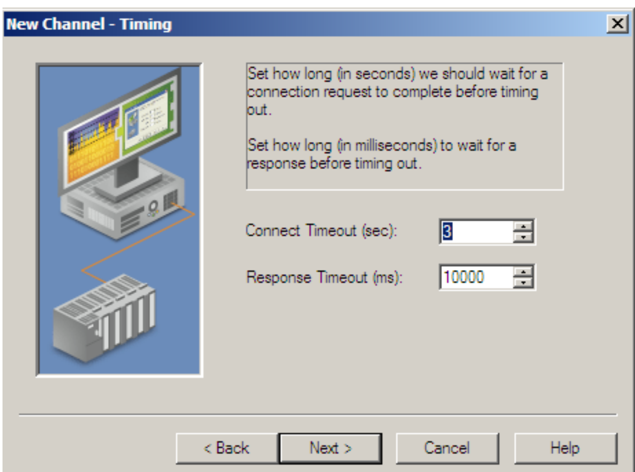
Step 6 : No Need to select VPN in this step .



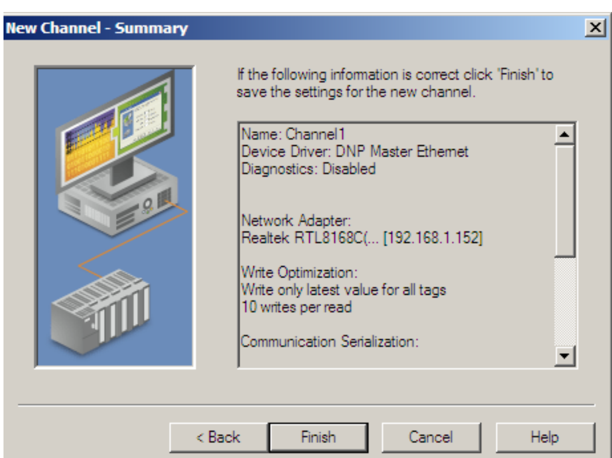
Step 7 : select TCP protocol , Write IP address of RTU and communication port (20,000 as default) in this stage .



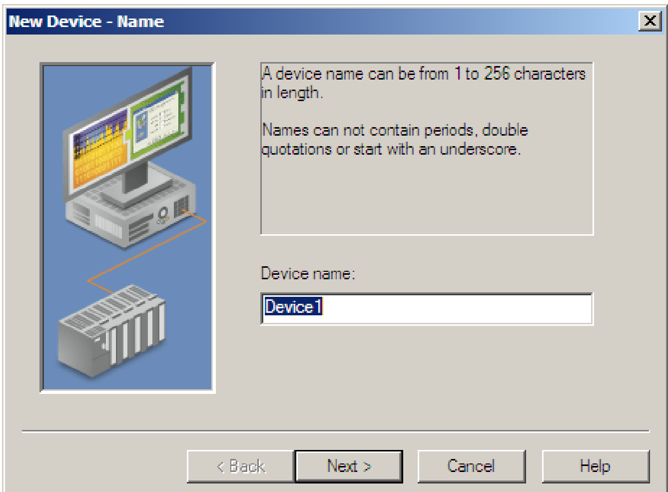
Step 8 : Keep timeout times as default .



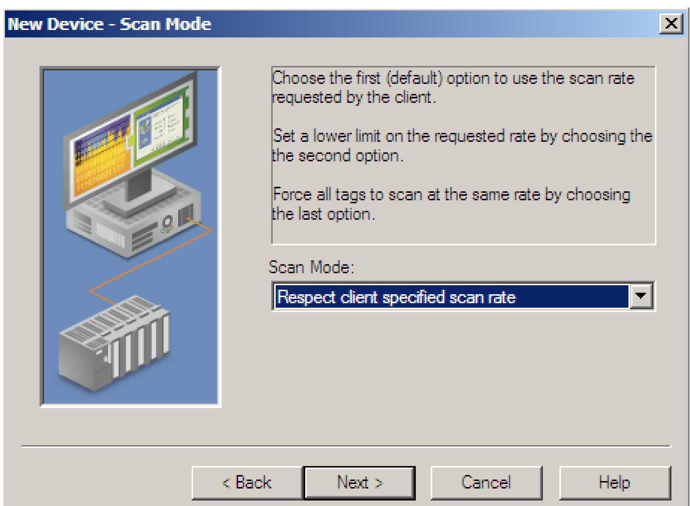
Step 9 : Communication channel configuration is done on this stage . Click on Finish button .



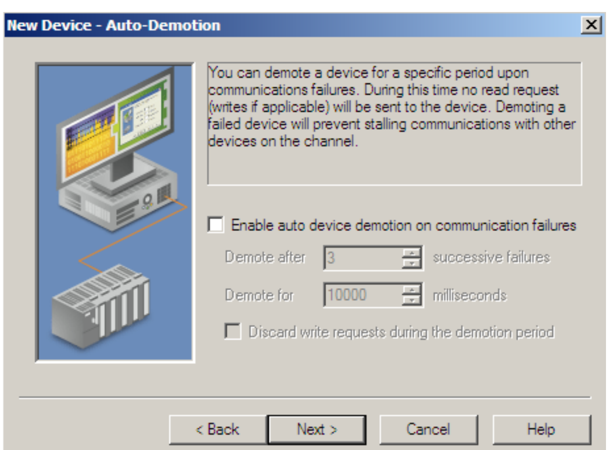
Step 10 : click on Add device item .



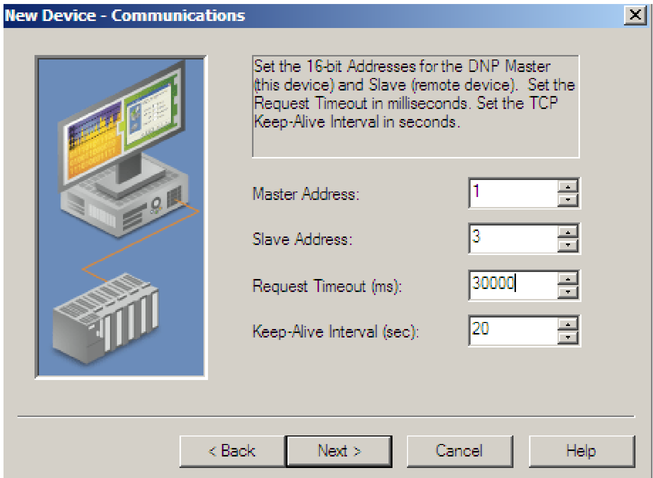
Step 11 : Keep Scan mode as default .



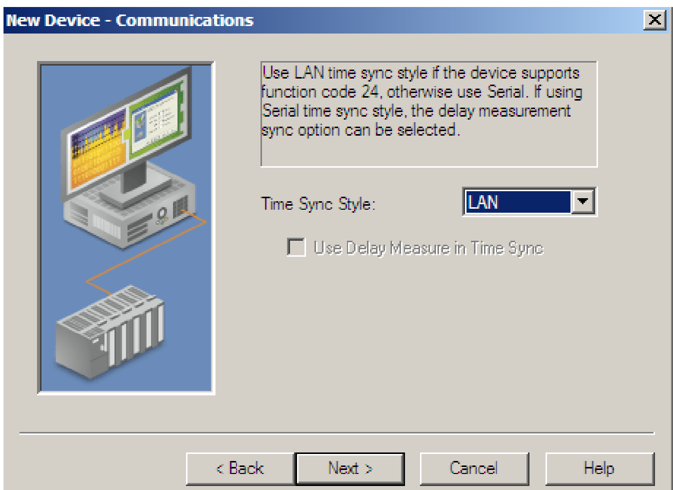
Step 12 : Keep Auto Demotion as default .



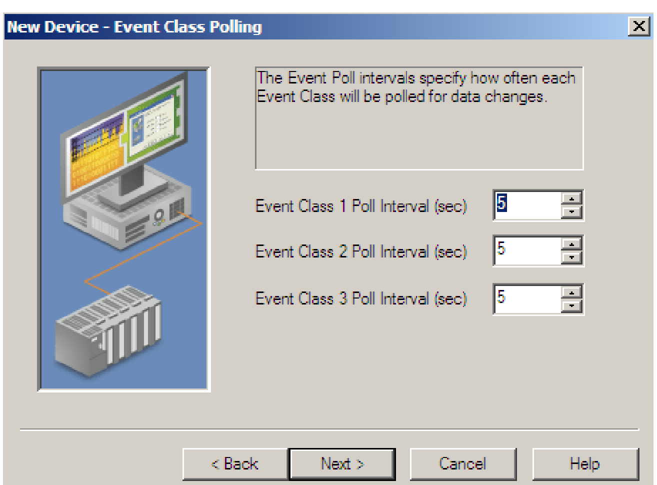
Step 13 : Write DNP3 Slave and Master Address and Keep-Alive Timer to 20 sec .



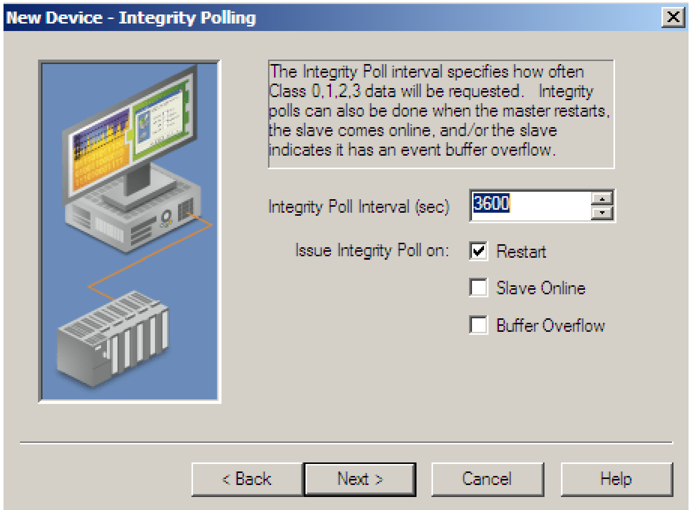
Step 14 : Keep Time synchronization as LAN .



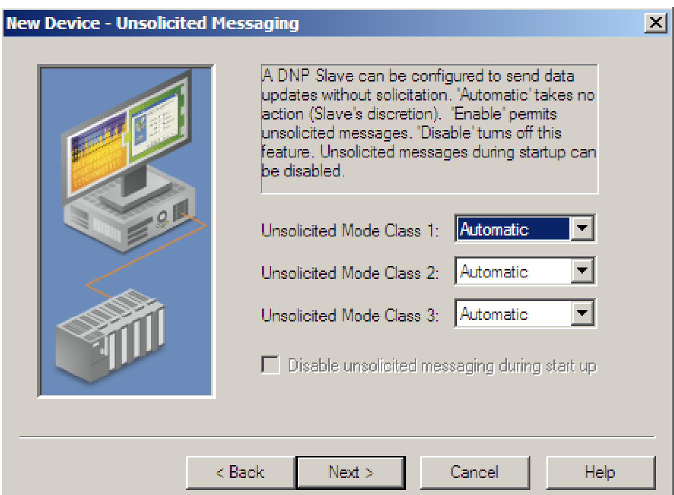
Step 15 : Set read class poll to 5 sec for reading changes from RTU every 5 Sec.



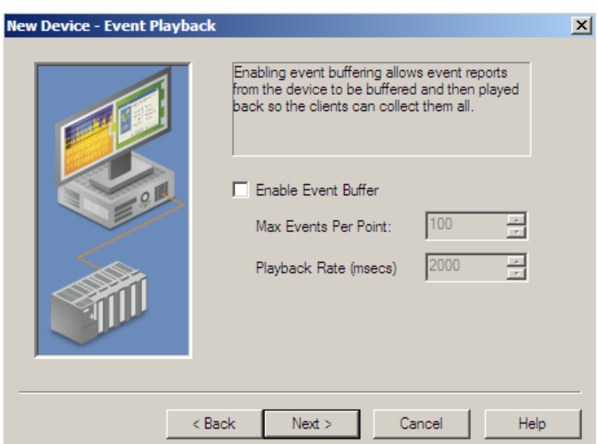
Step 16 : Set Send Integrity poll Parameter as following :



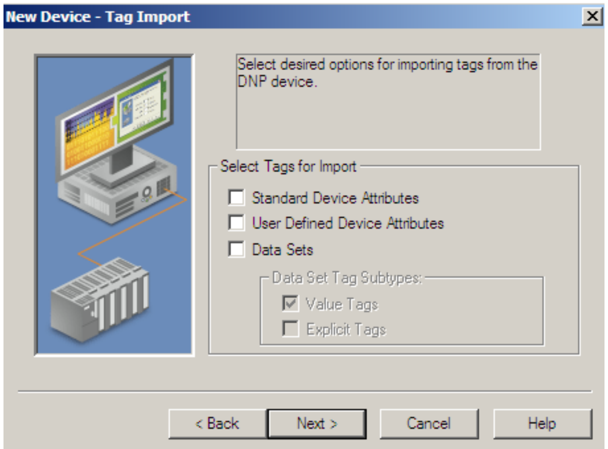
Step 17 : set Unsolicited communication to automatic as following :



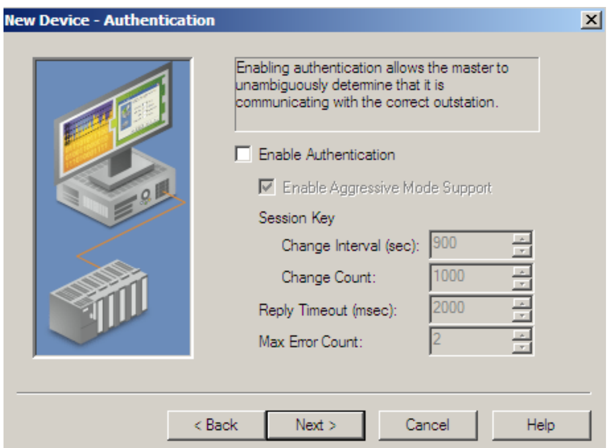
Step 18 : Keep Play Back Event to disable as default .



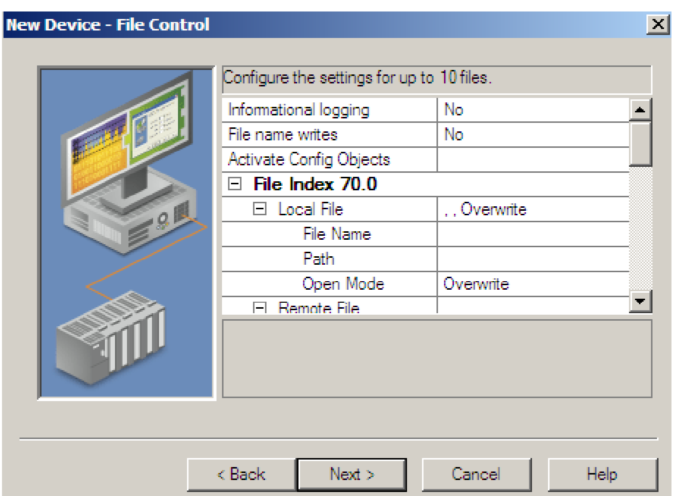
Step 19 : No need to import tags we will define tags manually.



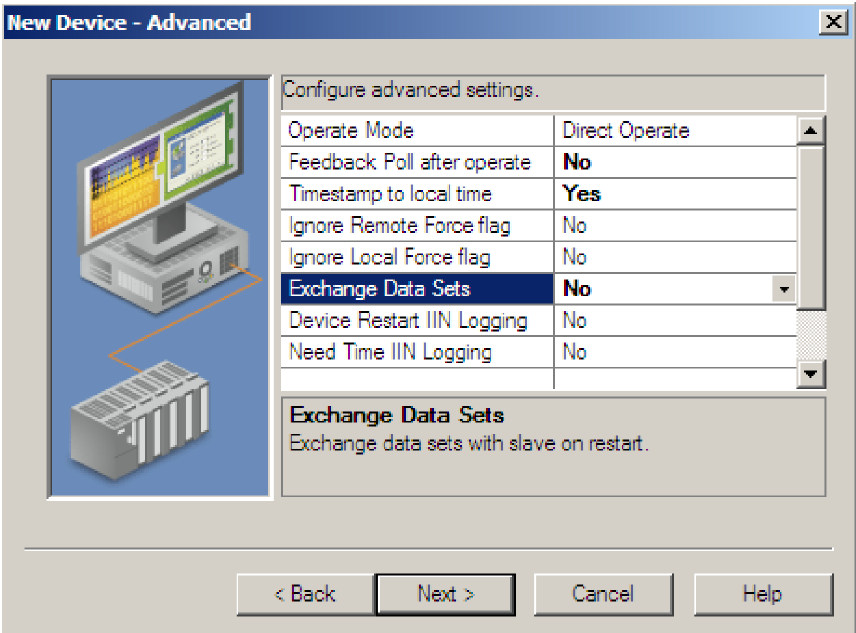
Step 20 : No Need to define Authentication .pbsSoftLogic DNP3 driver still not supports DNP3 Authentication .



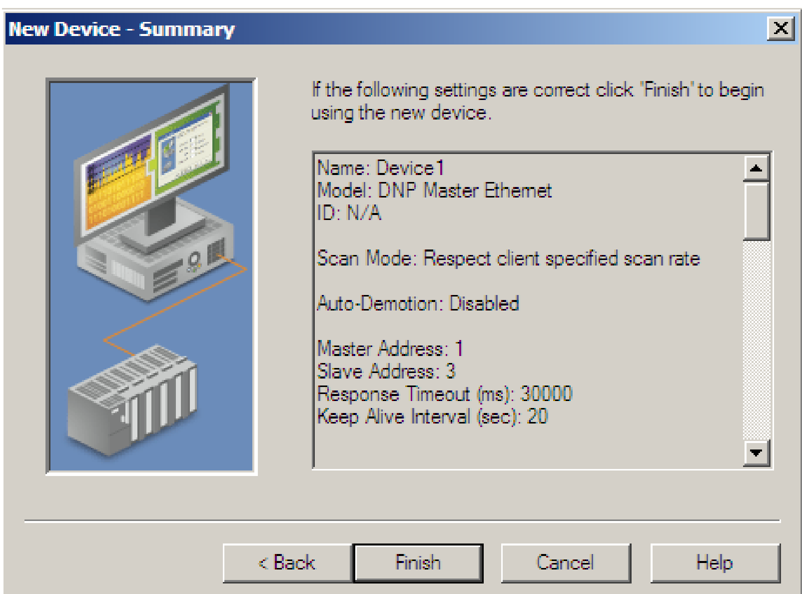
Step 21 : Pass File control page . pbsSoftLogic DNP3 driver still not supports File Transfer functionality .



Step 22:Set Advanced parameters as following :

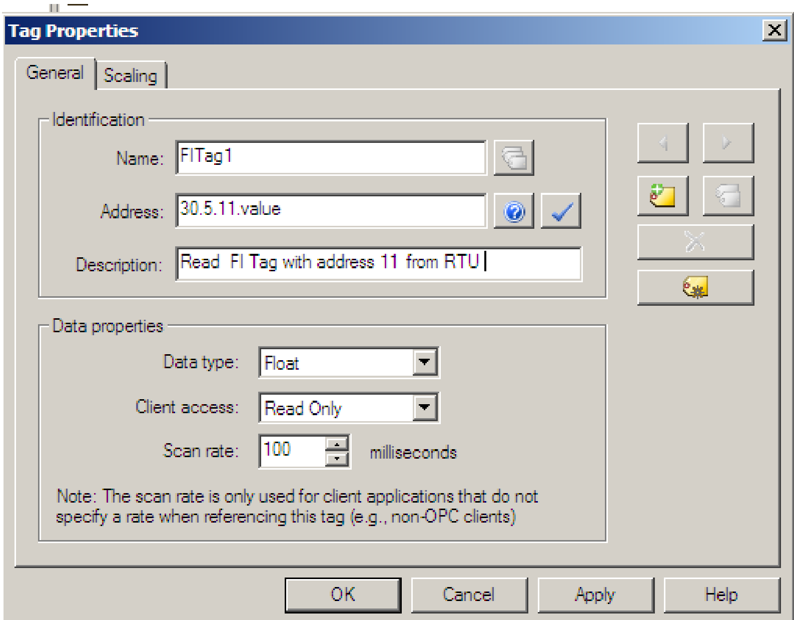


Step 23 : you finished Device configuration in this stage .Click on Finish Button .



Step 24 : In this stage you should define DNP3 Tags for OPC Server.

Reading Float Signal value from RTU by OPC Server define one float tag as following:



Tag address in OPC : DNPGroupNumber.DNPVariation.DNPTagAddress.Value

DNP3 Object Library			
		Group:	30
		Variation:	5
Group Name:	Analog Input	Type:	Static
Variation Name:	Single-precision, floating-point with flag	Parsing Codes:	Table 12-14

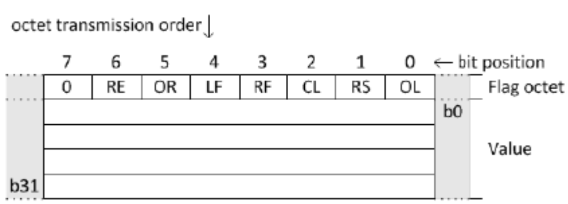
A.14.5.1 Description

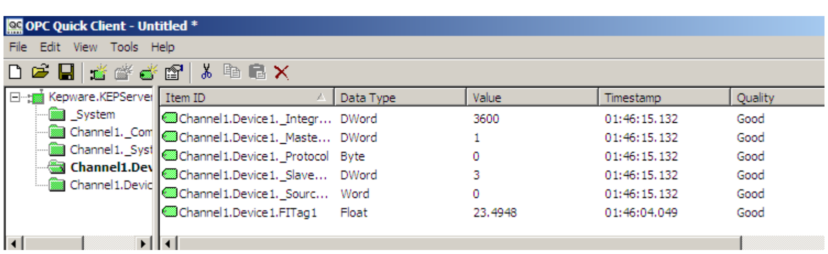
Object group 30, variation 5 is used to report the current value of an analog input point. See 11.9.1 for a description of an Analog Input Point Type.

Variation 5 objects contain a flag octet and a single-precision, floating-point value.

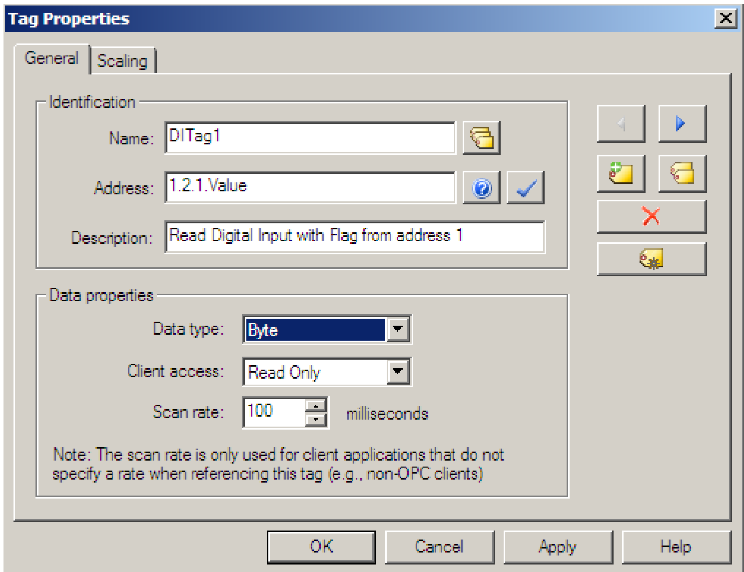
A.14.5.2 Coding

A.14.5.2.1 Pictorial





Reading DNP3 Digital Input Tag from RTU by OPC Server: Define an OPC tag as following:



A.2.2 Binary input—with flags

DNP3 Object Library

Group Name:	Binary Input	Group:	1
Variation Name:	With flags	Variation:	2
		Type:	Static
		Parsing Codes:	Table 12-2

A.2.2.1 Description

Object group 1, variation 2 is used to report the current value of a binary input point. See 11.9.8 for a description of a Binary Input Point Type.

Variation 2 objects contain a status octet that includes the state of the binary input.

A.2.2.2 Coding

A.2.2.2.1 Pictorial

octet transmission order ↓

7	6	5	4	3	2	1	0	← bit position
ST	0	CF	LF	RF	CL	RS	OL	State and flag octet

A.2.2.2.2 Formal structure

BSTR8: Flag Octet

Bit 0: ONLINE

Bit 1: RESTART

Bit 2: COMM_LOST

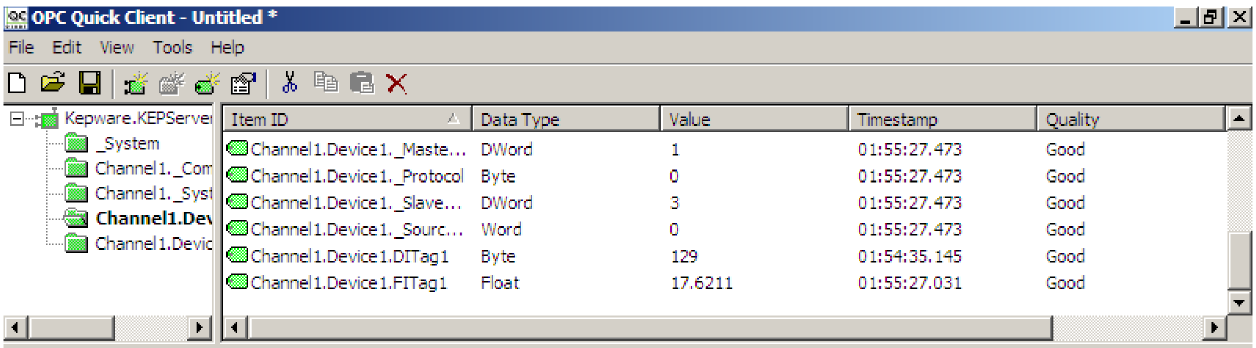
Bit 3: REMOTE_FORCED

Bit 4: LOCAL_FORCED

Bit 5: CHATTER_FILTER

Bit 6: Reserved, always 0

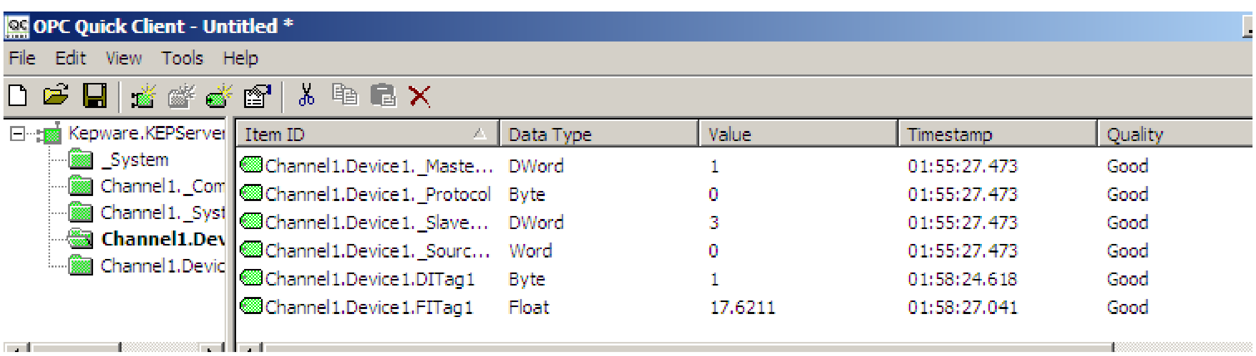
Bit 7: STATE—Has a value of 0 or 1, representing the state of the physical or logical input.



When Value of Signal is 129 in OPC Server , it means that :

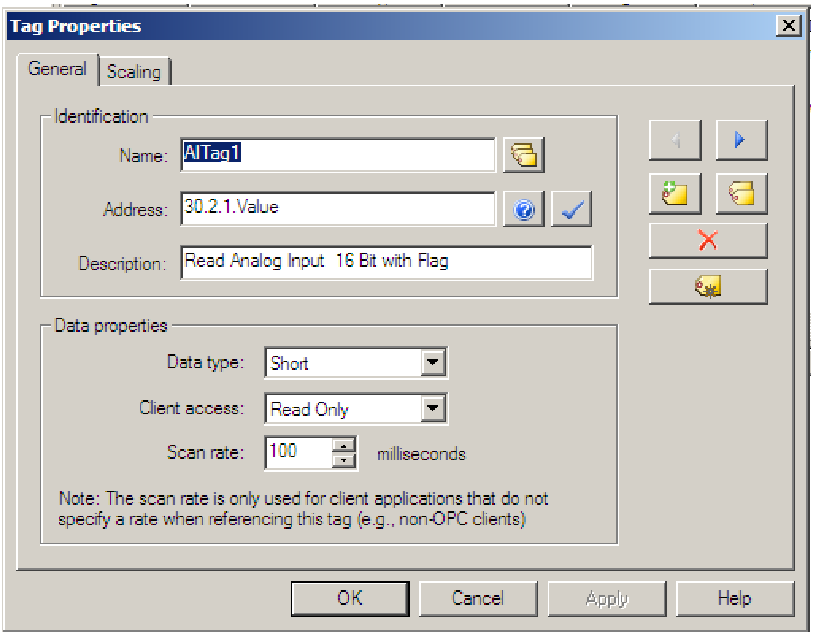
Bit 0 is Online

Bit 7 is 1 (Signal Value is 1)



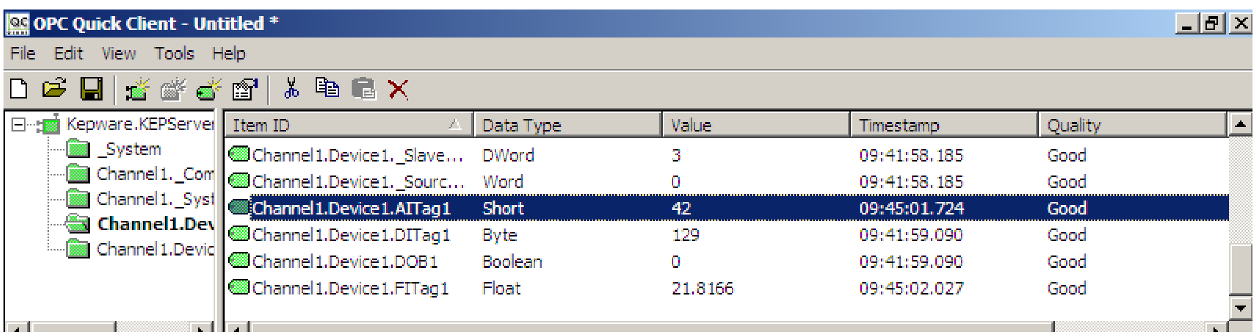
When Value of signal is 1 It means Bit 0 is online and Bit 7 (Signal Value) is 0

Reading Analog Input 16 Bit with Flag :



For reading Analog Input tags from RTU you need to define OPC Tag with Group 30 .

For Reading as 16 Bit Value, use Variation 2.



A.14.2 Analog input—16-bit with flag

DNP3 Object Library			
		Group:	30
		Variation:	2
Group Name:	Analog Input	Type:	Static
Variation Name:	16-bit with flag	Parsing Codes:	Table 12-14

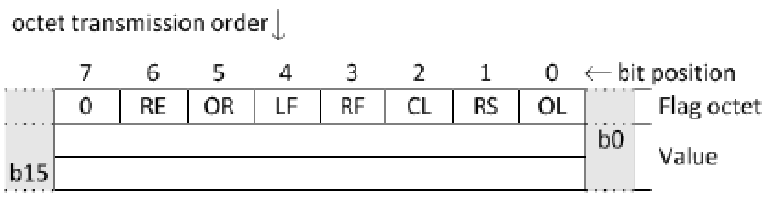
A.14.2.1 Description

Object group 30, variation 2 is used to report the current value of an analog input point. See 11.9.1 for a description of an Analog Input Point Type.

Variation 2 objects contain a flag octet and a 16-bit, signed integer value.

A.14.2.2 Coding

A.14.2.2.1 Pictorial



A.14.2.2.2 Formal structure

BSTR8: Flag Octet

Bit 0:	ONLINE
Bit 1:	RESTART
Bit 2:	COMM_LOST
Bit 3:	REMOTE_FORCED
Bit 4:	LOCAL_FORCED
Bit 5:	OVER_RANGE
Bit 6:	REFERENCE_ERR
Bit 7:	Reserved, always 0.

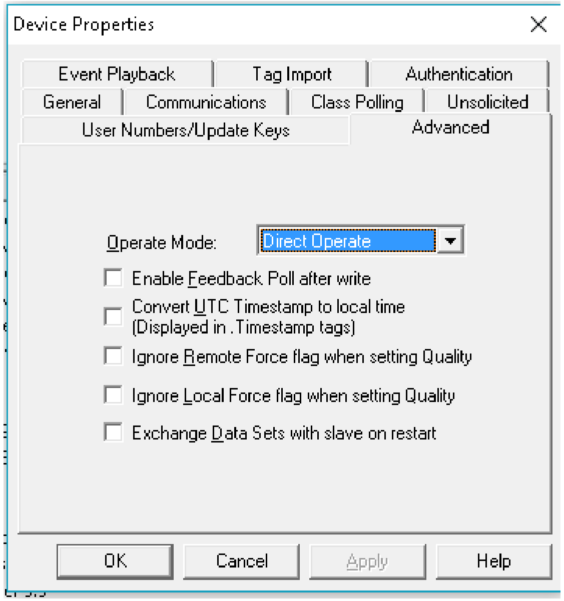
INT16: Value

This is the most recently measured, obtained, or computed value.

Range is –32 768 to +32 767.

Important Points for AOB and DOB Tag Writing by kepware DNP3 OPC Server to RTU:

- Always for any AOB or DOB Tags you MUST define AO and DO Tags with same addressing. Otherwise Kepware AOB or DOB tags will not get online status.
- In Device Advanced Properties , remove check mark for" Enable Feed Back Poll after Write"



DNP3 Driver is only supported Short and Long Write for AOB Tags.

So you should define AOB or DOB tags as following:

AOBTag1	40.1.1.Value	Long
AOBTag2	40.2.2.Value	Short
DOBTag1	10.0.1.Value	Boolean

40 : AO Tag Write

1: Long Write

2:Short Write

9 – IEC870-5 Slave (101-104) Configuration

pbsSoftLogic supports IEC870-5-101/104 protocols for communication with master SCADA .

You can setup maximum four IEC slave instance for each RTU. It means you can connect to 4 Separate SCADA master in the same time.

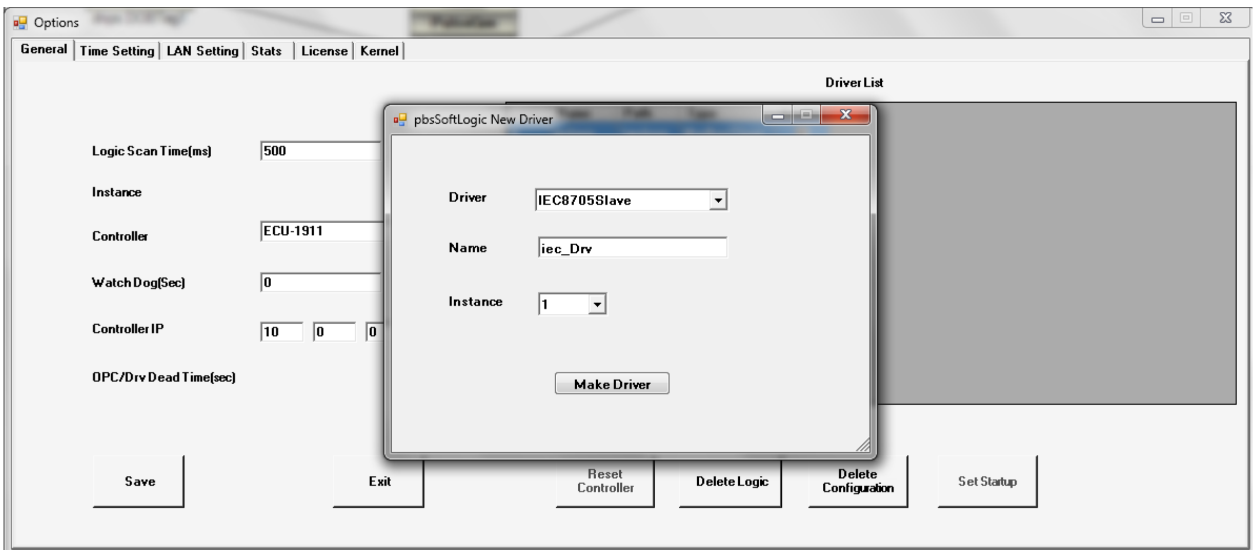
IEC870-5-101 is communicating over RS232 and IEC870-5-104 is communicating over TCP.

For each IEC Driver instance you can define 1024 IEC Tags.

Defining new IEC Driver:

Open project setting and right click on driver list. Select new driver and then select IEC8705Slave .

Type Deriver name and select instance as following figure.



pbsSoftlogic will make a default configuration and IEC tags in a directory located at logic path . Directory name is name of driver.

IEC870-5 driver files:

- Options.xml define communication parameters
- IECSTags.xml define IEC slave tags

Communication parameters : optione.xml file content :

```
 <Node>
     <Name>PhysicalLayer</Name>
     <Desc>RS232 , TCP</Desc>
     <Value>RS232</Value>
  </Node>
  <Node>
     <Name>COMPort</Name>
     <Desc>Serial Port for Communication 1,2,3,4,5,...</Desc>
     <Value>1</Value>
  </Node>
  <Node>
     <Name>BaudRate</Name>
     <Desc>9600,19200,36400,52700,115200</Desc>
     <Value>19200</Value>
  </Node>
  <Node>
     <Name>SlaveAddress</Name>
     <Desc>SlaveAddress</Desc>
     <Value>3</Value>
  </Node>
```

```
<Node>
    <Name>MasterIPAddress</Name>
    <Desc>MasterIPAddress</Desc>
    <Value>127.0.0.1</Value>
</Node>
<Node>
    <Name>TCPIPPort</Name>
    <Desc>TCPIPPort</Desc>
    <Value>2404</Value>
</Node>
<Node>
    <Name>MasterAddress</Name>
    <Desc>MasterAddress</Desc>
    <Value>1</Value>
</Node>
<Node>
    <Name>LocalIPAddress</Name>
    <Desc>LocalIPAddress</Desc>
    <Value>127.0.0.1</Value>
</Node>
<Node>
    <Name>PhysicalLayerScanTime</Name>
    <Desc>PhysicalLayerScanTime</Desc>
    <Value>100</Value>
</Node>
```

```
<Node>
    <Name>Instance</Name>
    <Desc>Instance</Desc>
    <Value>1</Value>
</Node>
<Node>
    <Name>COTZ</Name>
    <Desc>Cause of Transmition Size 1,2 </Desc>
    <Value>1</Value>
</Node>
<Node>
    <Name>CAOAZ</Name>
    <Desc>Common Address of ASDU Size 1,2 </Desc>
    <Value>1</Value>
</Node>
<Node>
    <Name>IOZ</Name>
    <Desc>Information Object Size Size 1,2,3</Desc>
    <Value>1</Value>
</Node>
<Node>
    <Name>MODE</Name>
    <Desc>Communication Mode Balance(B) , Unbalan(U)  </Desc>
    <Value>B</Value>
</Node>
```

<Node>

<Name>KParam</Name>

<Desc>KParameter 1~ 32767 max difference recive sequence number to send state variable</Desc>

<Value>12</Value>

</Node>

<Node>

<Name>WParam</Name>

<Desc>WParameter 1~ 32767 Latest ACK after reciving W I-format APDUs</Desc>

<Value>8</Value>

</Node>

<Node>

<Name>T0Param</Name>

<Desc>T0Parameter Timeout of Connection establishment(sec)</Desc>

<Value>30</Value>

</Node>

<Node>

<Name>T1Param</Name>

<Desc>T1Parameter Timeout of Send test APDU(sec)</Desc>

<Value>15</Value>

</Node>

<Node>

<Name>T2Param</Name>

<Desc>T2Parameter Timeout for ACK in case of no data message (sec)</Desc>

<Value>10</Value>

</Node>

```
<Node>
    <Name>T3Param</Name>
    <Desc>T3Parameter  Timeout for sending test frames in case of a long idle state  (sec)</Desc>
    <Value>20</Value>
</Node>
```

IEC Slave Tag file: IECSTags.xml

Name: Tag Name. Should be unique in your logic

Type: IEC Tags type. Following type is supported:

- DI (Digital input) IEC Tag Type 1 ,30, M_SP_NA_1
- AI (Analog Input) IEC Tag Type 9,34,M_ME_NA_1 ,M_ME_TD_1
- FI(Float Input) IEC Tag Type 13 ,36 M_ME_NC_1 ,M_ME_TF_1
- CNT (Counter) IEC Tag Type 15 , 37 M_IT_NA_1,M_IT_TB_1
- DPI (Double Point Information) IEC Tag Type 3,4 ,M_DP_NA_1,M_DP_TA_1
- DO (Digital Output) IEC Tag Type 45 , C_SC_NA_1
- AO (Analog Output) IEC Tag Type 48 , C_SE_NA_1
- FO (Float Output) IEC Tag Type 50 ,C_SE_NC_1
- DPO(Double command) IEC Tag Type 46 , C_DC_NA_1

- **Process information in monitor direction**
- <1> := Single-point information (M_SP_NA_1)
- <3> := double-point information (M_DP_NA_1)
- <4> := double-point information with time tag (M_DP_TA_1)
- <9> := Measured value, normalized value (M_ME_NA_1)
- <13> := Measured value, short floating point value (M_ME_NC_1)
- <15> := Integrated totals (M_IT_NA_1)
- <21> := Measured value, normalized value without quality descriptor (M_ME_ND_1)
- <30> := Single-point information with time tag CP56Time2a (M_SP_TB_1)
- <34> := Measured value, normalized value with time tag CP56Time2a(M_ME_TD_1)
- <36> := Measured value, short floating point value with time tag CP56Time2a (M_ME_TF_1)
- <37> := Integrated totals with time tag CP56Time2a (M_IT_TB_1)

Process information in control direction

<45> := Single command (C_SC_NA_1)

<46> := double command (C_DC_NA_1)

<48> := Set point command, normalized value (C_SE_NA_1)

<50> := Set point command, short floating point value (C_SE_NC_1)

System information in monitor direction

<70> := End of initialization (M_EI_NA_1)

System information in control direction

<100>:= Interrogation command (C_IC_NA_1)

<101>:= Counter interrogation command (C_CI_NA_1)

<103>:= Clock synchronization command (C_CS_NA_1)

Basic application functions

Station initialization

Cyclic data transmission

Spontaneous transmission

Global Station interrogation

Clock synchronization

Command transmission

- Direct command transmission
- Direct set point command transmission
- Select and execute command
- Select and execute set point command
- **Transmission of integrated totals**
- Mode B: Local freeze with counter interrogation
- Counter read
- Counter freeze without reset
- Counter freeze with reset
- Counter reset
- General request counter

Class : IEC Supported two classes , Class1 and Class2 .

From IEC870-5-101 standard:

The polling procedure is supported by the link layer which requests user data of classes 1 and 2. In general, ASDUs containing the causes of transmission periodic/cyclic are assigned to be transmitted with the link layer data class 2 and all time tagged or spontaneously transmitted ASDUs are assigned to be transmitted with the link layer data class 1. Other ASDUs with other causes of transmission of low priority such as background scan may also be assigned to data class 2 and must be listed in the interoperability document.
In this case, it has to be considered that the link request of class 1 occurs at a different point of time (to or from) the link request of class 2, which may influence the correct sequence of the ASDUs delivered to the application layer of the controlling station.
In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available.

Init : IEC Tag Init Value

Address : IEC Tag Address

: Log : When set to 1 for DO , AO ,FO and DPO Tags , RTU will keep last value of Set Point in internal memory flash and if you restart RTU , it will use latest set points from Master SCADA . RTU will check AO , DO , FO and DPO changes every min and if it detect changes, it will save them on internal flash memory.

```
<Tag Name="FITag6" Type="FI" Class="1" Init="0" Address="6" Log="0" />
<Tag Name="FITag7" Type="FI" Class="1" Init="0" Address="7" Log="0" />
<Tag Name="FITag8" Type="FI" Class="1" Init="0" Address="8" Log="0" />
<Tag Name="CNTTag1" Type="CNT" Class="1" Init="0" Address="1" Log="0" />
<Tag Name="CNTTag2" Type="CNT" Class="1" Init="0" Address="2" Log="0" />
<Tag Name="CNTTag3" Type="CNT" Class="1" Init="0" Address="3" Log="0" />
<Tag Name="CNTTag4" Type="CNT" Class="1" Init="0" Address="4" Log="0" />
<Tag Name="CNTTag5" Type="CNT" Class="1" Init="0" Address="5" Log="0" />
<Tag Name="CNTTag6" Type="CNT" Class="1" Init="0" Address="6" Log="0" />
<Tag Name="CNTTag7" Type="CNT" Class="1" Init="0" Address="7" Log="0" />
<Tag Name="CNTTag8" Type="CNT" Class="1" Init="0" Address="8" Log="0" />
<Tag Name="DPITag1" Type="DPI" Class="1" Init="0" Address="1" Log="0" />
<Tag Name="DPITag2" Type="DPI" Class="1" Init="0" Address="2" Log="0" />
<Tag Name="DPITag3" Type="DPI" Class="1" Init="0" Address="3" Log="0" />
<Tag Name="DPITag4" Type="DPI" Class="1" Init="0" Address="4" Log="0" />
<Tag Name="DPITag5" Type="DPI" Class="1" Init="0" Address="5" Log="0" />
<Tag Name="DPITag6" Type="DPI" Class="1" Init="0" Address="6" Log="0" />
<Tag Name="DPITag7" Type="DPI" Class="1" Init="0" Address="7" Log="0" />
<Tag Name="DPITag8" Type="DPI" Class="1" Init="0" Address="8" Log="0" />
<Tag Name="DOTag1" Type="DO" Class="1" Init="0" Address="1" Log="0" />
```

IEC101/104 State Tag:

Based on IEC101 /104 standards each Tag has a quality descriptor field.

Quality descriptor shows tag status.

7.2.6.3 Quality descriptor (separate octet)

The quality descriptor consists of five defined quality bits which may be set independently from each other. The quality descriptor provides the controlling station with additional information on the quality of an information object.

QDS		:=	CP8{OV,RES,BL,SB,NT,IV}	
OV		:=	BS1[1]<0..1>	(Type 6)
	<0>	:=	no overflow	
	<1>	:=	overflow	
RES = RESERVE		:=	BS3[2..4]<0>	(Type 6)
BL		:=	BS1[5]<0..1>	(Type 6)
	<0>	:=	not blocked	
	<1>	:=	blocked	
SB		:=	BS1[6]<0..1>	(Type 6)
	<0>	:=	not substituted	
	<1>	:=	substituted	
NT		:=	BS1[7]<0..1>	(Type 6)
	<0>	:=	topical	
	<1>	:=	not topical	
IV		:=	BS1[8]<0..1>	(Type 6)
	<0>	:=	valid	
	<1>	:=	invalid	

OV = OVERFLOW/NO OVERFLOW

The value of the INFORMATION OBJECT is beyond a predefined range of value (mainly applicable to analog values).

BL = BLOCKED/NOT BLOCKED

The value of the INFORMATION OBJECT is blocked for transmission; the value remains in the state that was acquired before it was blocked. Blocking and deblocking may be initiated for example by a local lock or a local automatic cause.

SB = SUBSTITUTED/NOT SUBSTITUTED

The value of the INFORMATION OBJECT is provided by the input of an operator (dispatcher) or by an automatic source.

NT = NOT TOPICAL/TOPICAL

A value is topical if the most recent update was successful. It is not topical if it was not updated successfully during a specified time interval or if it is unavailable.

IV = INVALID/VALID

A value is valid if it was correctly acquired. After the acquisition function recognizes abnormal conditions of the information source (missing or non-operating updating devices) the value is then marked invalid. The value of the INFORMATION OBJECT is not defined under this condition. The mark INVALID is used to indicate to the destination that the value may be incorrect and cannot be used.

Intermediate devices may modify the quality descriptors BL, SB, NT and IV.

BL: if an intermediate device blocks the transmission of an information object, it shall assert the quality descriptor BL. Otherwise it shall report the quality descriptor BL as reported from the lower level device.

SB: if an intermediate device substitutes the value of an information object, it shall assert the quality descriptor SB. Otherwise it shall report the quality descriptor SB as reported from the lower level device.

NT: if an intermediate device cannot obtain the value of an information object, it shall assert the quality descriptor NT. Otherwise it shall report the quality descriptor NT as reported from the lower level device.

IV: if an intermediate device identifies that an information object is not valid, it shall assert the quality descriptor IV. Otherwise it shall report the quality descriptor IV as reported from the lower level device.

Example 1

Suppose that the monitored status of a circuit-breaker is blocked because the field interface is in test mode. In this case, the quality descriptor (BL = 1 “blocked”) will be transferred unchanged through all system levels from the field interface to the controlling station.

Example 2

A substituted value may be assigned automatically or manually to a measured value, for example when the data acquisition is disturbed. This substituted measured value is transmitted to the controlling station with the quality bit SB = 1 substituted.

If the value of an information object is automatically marked with a new quality descriptor due to specific conditions, the quality descriptor may be reset manually or automatically when the conditions change.

If a given information object is normally only reported spontaneously, every change of the quality descriptor initiates a spontaneous transmission. Information objects with a time tag are transmitted with the point of time at which the change of the quality descriptor occurred.

7.2.6.1 Single-point information (IEV 371-02-07) with quality descriptor

SIQ		:=	CP8{SPI,RES,BL,SB,NT,IV}
SPI		:=	BS1[1]<0..1>
	<0>	:=	OFF
	<1>	:=	ON
RES = RESERVE		:=	BS3[2..4]<0>
BL		:=	BS1[5]<0..1>
	<0>	:=	not blocked
	<1>	:=	blocked
SB		:=	BS1[6]<0..1>
	<0>	:=	not substituted
	<1>	:=	substituted
NT		:=	BS1[7]<0..1>
	<0>	:=	topical
	<1>	:=	not topical
IV		:=	BS1[8]<0..1>
	<0>	:=	valid
	<1>	:=	invalid

7.2.6.2 Double-point information (IEV 371-02-08) with quality descriptor

DIQ		:=	CP8{DPI,RES,BL,SB,NT,IV}	
DPI		:=	UI2[1..2]<0..3>	(Type 1.1)
	<0>	:=	indeterminate or intermediate state	
	<1>	:=	determined state OFF	
	<2>	:=	determined state ON	
	<3>	:=	indeterminate state	
RES = RESERVE		:=	BS2[3..4]<0>	(Type 6)
BL		:=	BS1[5]<0..1>	(Type 6)
	<0>	:=	not blocked	
	<1>	:=	blocked	
SB		:=	BS1[6]<0..1>	(Type 6)
	<0>	:=	not substituted	
	<1>	:=	substituted	
NT		:=	BS1[7]<0..1>	(Type 6)
	<0>	:=	topical	
	<1>	:=	not topical	
IV		:=	BS1[8]<0..1>	(Type 6)
	<0>	:=	valid	
	<1>	:=	invalid	

Defining Tag State

You need to define a state tag exactly after IEC tag definition in IECSTags.xml file.

```
<Tag Name="DITag1" Type="DI" Class="1" Init="0" Address="1" Log="0" />
<Tag Name="DITag1.S" Type="DIS" Class="1" Init="0" Address="1" Log="0" />

<Tag Name="DITag2" Type="DI" Class="1" Init="0" Address="2" Log="0" />
<Tag Name="DITag3" Type="DI" Class="1" Init="0" Address="3" Log="0" />
<Tag Name="DITag4" Type="DI" Class="1" Init="0" Address="4" Log="0" />

<Tag Name="AITag1" Type="AI" Class="1" Init="0" Address="1" Log="0" />
<Tag Name="AITag1.s" Type="AIS" Class="1" Init="0" Address="1" Log="0" />

<Tag Name="AITag2" Type="AI" Class="1" Init="0" Address="2" Log="0" />
<Tag Name="AITag2.s" Type="AIS" Class="1" Init="0" Address="2" Log="0" />


<Tag Name="AITag3" Type="AI" Class="1" Init="0" Address="3" Log="0" />
<Tag Name="AITag4" Type="AI" Class="1" Init="0" Address="4" Log="0" />
<Tag Name="AITag8" Type="AI" Class="1" Init="0" Address="8" Log="0" />

<Tag Name="FITag1" Type="FI" Class="1" Init="0" Address="1" Log="0" />
<Tag Name="FITag1.s" Type="FIS" Class="1" Init="0" Address="1" Log="0" />
```

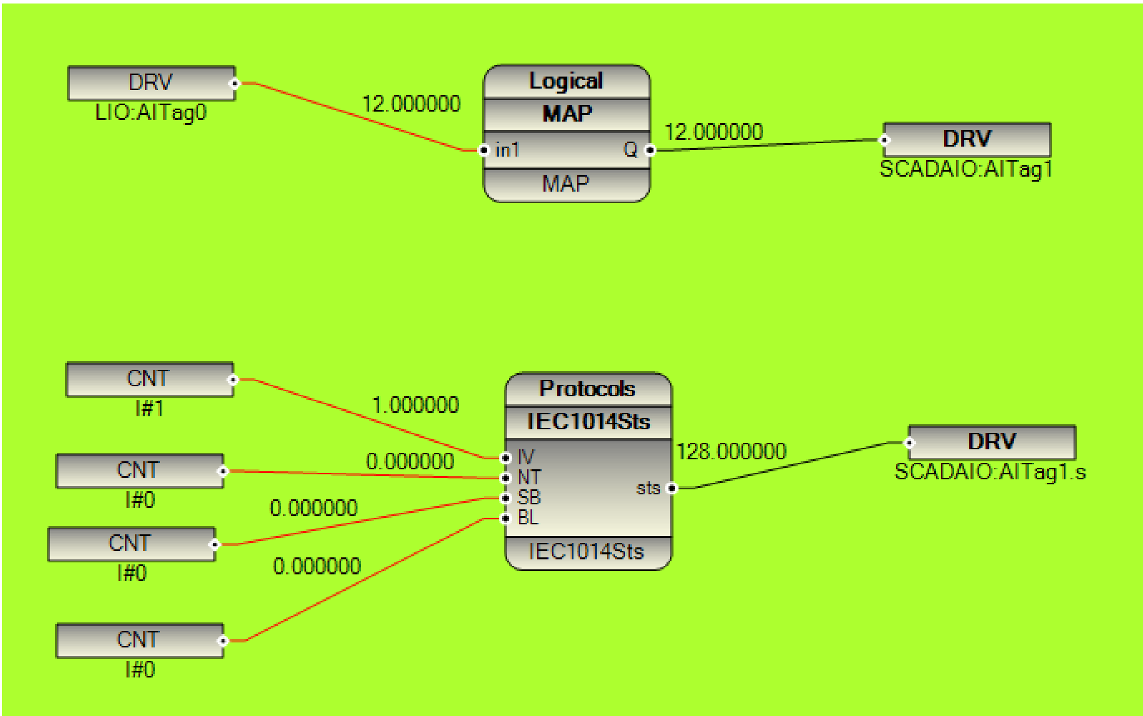
Note: State tag MUST be defined exactly after IEC Tag.

Look at Above example: DITag1 and DITag1.s   Tag name MUST be different with IEC tag . You can add .s or _s to IEC as an example.

There are following State tag types:

- DIS : State Tag type for DI
- AIS : State Tag type for AI
- FIS : State Tag Type for FI
- DPIS : State Tag Type for DPI
- CNTS : State Tag Type for CNT (Counters)

You need to write State Tag in RTU Logic. You can use IEC1014Sts Function Block to make State Tag Signal in your logic. IV, NT, SB and BL are defined in the IEC101/104 standard.



Note: IEC1014Sts is a Lua Function block and you must transfer it to controller for proper operation of your logic. Please look at Lua User defined FB for detail information.

IEC1014Sts is used for DIS, DPIS, AIS and FIS State Tags.

For counters, you need to set only IV filed.

- IV = 0 Counter value is valid
- IV = 1 Counter value is not valid

So value of State tag for counter is only 0 or 1.

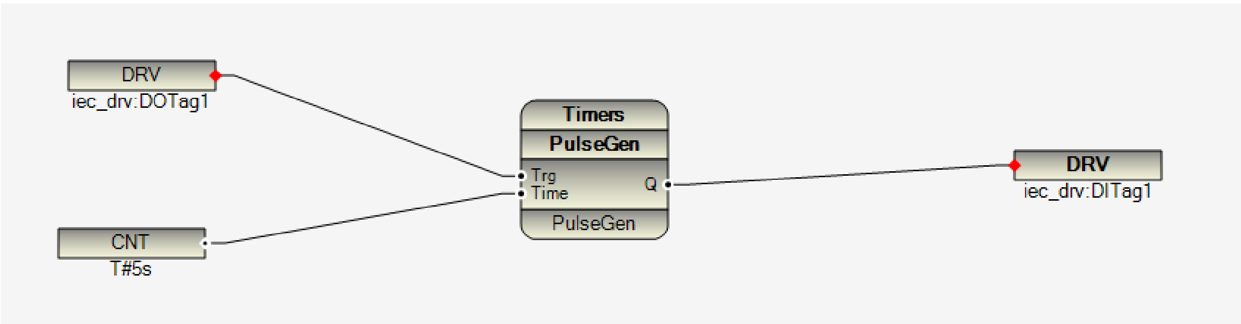
IEC 870-5 Slave driver Operation:

1 - Master SCADA will read all Input Signals (DI , AI , FI , DPI ,CNT)

- You need to write all Input Signals in your logic.(Link to FB right ports)

2 – Master SCADA will write Output Signals (DO , AO,FO ,DPO)

- You need to read all Output Tags in your logic (Link to FB left Ports)



In above logic master will write to iec_drv:DOTag1 and will read iec_drv:DITag1

10 - User defined function block by Lua Scripting and C Language

pbsSoftLogic has open structure for adding new Function block by user to platform .

User defined FB (UDF) has the same performance as internal FB in pbsSoftLogic.

You need to use Lua scripting language for writing UDF code and with help of XML file you can define UDF body .

Lua – www.Lua.org- is one the most famous scripting language in the market and it is used in many projects and applications world wised.

pbsSoftLogic Linux runtime engine supports Lua Ver 5.2.2 which is latest version .

For learning Lua language , please refer to www.lua.org web site .

Three steps are required for adding UDF to pbsSoftLogic:

1- Defining FB Input / Output structure
2- Writing FBD Inside by Lua scripting

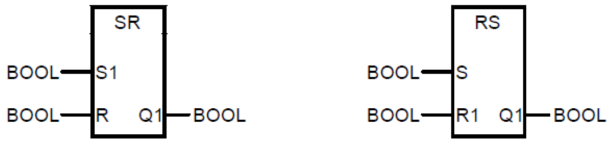
C Source code of all internal FB are included in pbsSoftLogic. You can use these source codes to make new FB and expand platform.

In this section, we will describe details of above steps with implementation of a simple UDF.

UDF is not related to a specific project, but it will include to platform.

For defining new UDF, you need to define new FB Group. FB Group includes many FBs.

Suppose we want to define a new FB Groups for IEC1131-3 standard and add two Function Block for RS and SR Flip Flop. In following figure you can see the definition of RS and SR flip flop from IEC1131-3 standard.

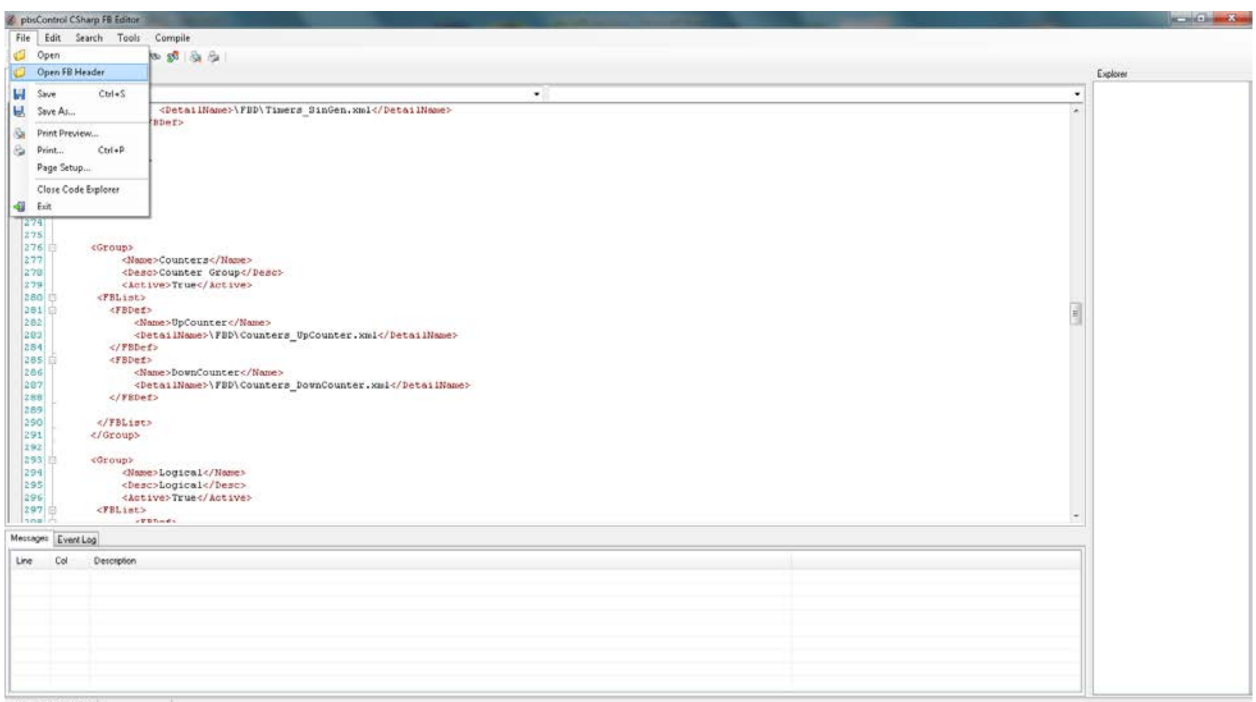



```
FUNCTION_BLOCK      SR          (* flip flop set dominant *)
  VAR_INPUT
    S1    :    BOOL;
    R     :    BOOL;
  END_VAR
  VAR_OUTPUT
    Q1    :    BOOL;
  END_VAR
  Q1      :=   S1 OR ( NOT R AND Q1);
END_FUNCTION_BLOCK

FUNCTION_BLOCK      RS          (* flip flop reset dominant *)
  VAR_INPUT
    S     :    BOOL;
    R1    :    BOOL;
  END_VAR
  VAR_OUTPUT
    Q1    :    BOOL;
  END_VAR
  Q1      :=   NOT R1 AND ( S OR Q1);
END_FUNCTION_BLOCK
```

Step1: Define FB body. Edit FBDefh.xml file in \PSLE\cfg directory.

Run Windows FB Editor Utility from Tools menu in pbsSoftLogic Editor. FB editor can be use for defining new FB body and CSharp implementation for Simulator and Windows Runtime Kernel.

Open FB header file from File menu and select “open FB Header”. It will open FBDefh.xml file.



FBDefh.xml file contains all pbsSoftLogic FB header (internal and UDF).

For each FB group, there is a Group Tag in FBDefh.xml file with following format:

```
<Group>
     <Name>Counters</Name>
     <Desc>Counter Group</Desc>
     <Active>True</Active>
 <FBList>
   <FBDef>
       <Name>UpCounter</Name>
       <DetailName>\FBD\Counters_UpCounter.xml</DetailName>
   </FBDef>
   <FBDef>
       <Name>DownCounter</Name>
       <DetailName>\FBD\Counters_DownCounter.xml</DetailName>
   </FBDef>

 </FBList>
</Group>
```

Above Group definition is for Counters Group. FBList tag contains all FB for this group. For each FB, there is an FBDef Tag with Name and DetailName elements.

Copy and paste counters Group Tag and change its tags as following:

```
<Group>
    <Name>IEC11313</Name>
    <Desc>IEC11313 Group</Desc>
    <Active>True</Active>
    <FBList>
        <FBDef>
            <Name>RS</Name>
            <DetailName>\FBD\IEC11313_RS.xml</DetailName>
        </FBDef>
        <FBDef>
            <Name>SR</Name>
            <DetailName>\FBD\IEC11313_SR.xml</DetailName>
        </FBDef>

    </FBList>
</Group>
```

Save FBDefh.xml file. You can define any number of FB header definition in FBList tag .

DetailName value is relative path of FB body definition XML file. Name value is Name of FB that is shown in FBeditor .

As a naming standard we will use following format for FB body definition file:

{groupName}_{FBName}.xml and all FB Body files are locate at \FBD\ directory .

Open \FBD\ directory and copy and paste one of existing FB Body files, change its name to IEC11313_RS.xml .change its content as following:

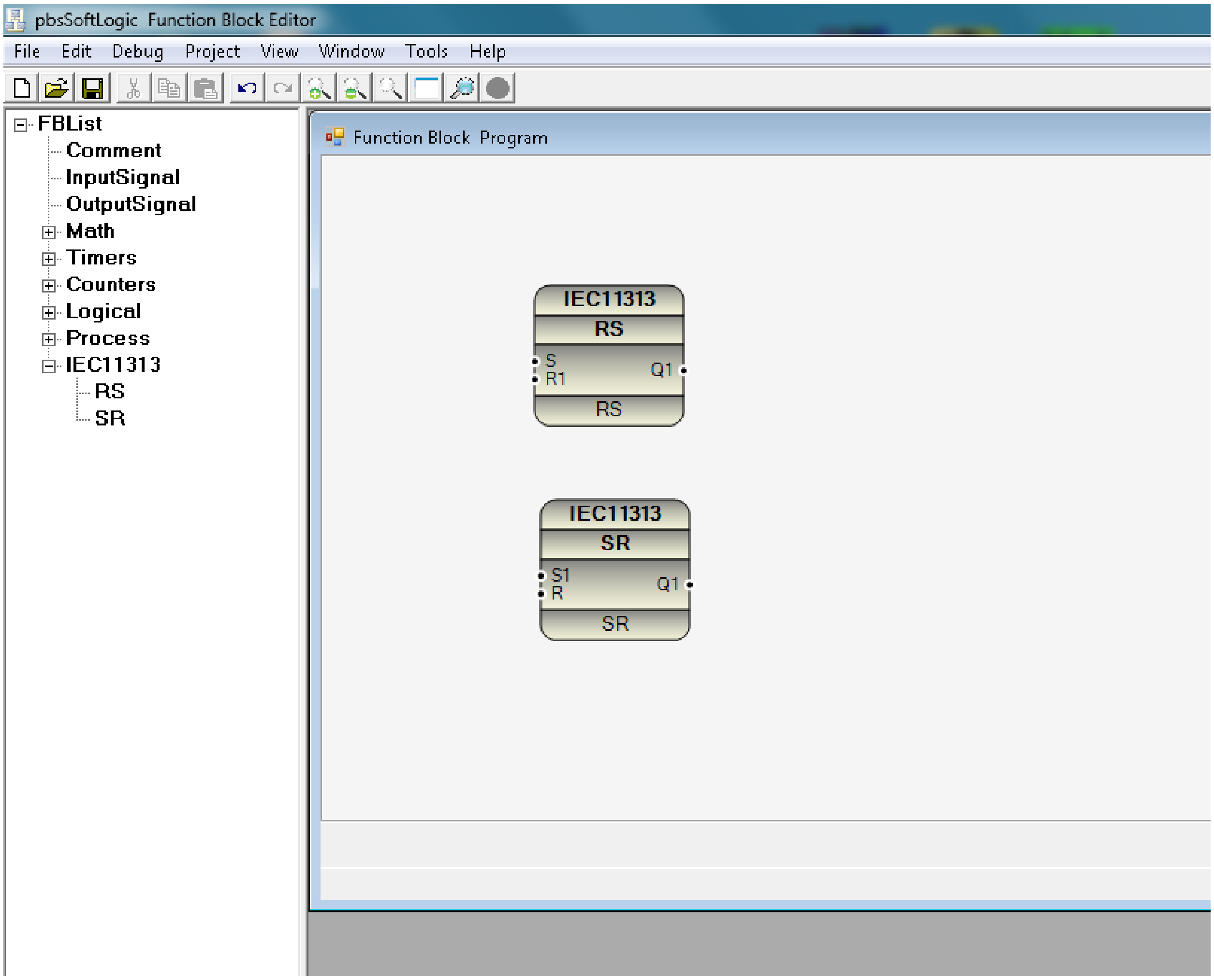
```
<?xml version="1.0"?>
<FBDef>
     <Version>1.0.0</Version>
     <FBDD>
          <Name>RS</Name>
          <Desc>RS Flip Flop</Desc>
          <Active>True</Active>
      <Interface></Interface>
      <InputList>
        <Input>
            <Name>S</Name>
            <Desc>Set Input</Desc>
            <Type>bool</Type>
            <Init>False</Init>
        </Input>
        <Input>
            <Name>R1</Name>
            <Desc>Reset Input</Desc>
            <Type>bool</Type>
            <Init>False</Init>
        </Input>

      </InputList>
      <OutputList>
        <Output>
            <Name>Q1</Name>
            <Desc>Q1 Output</Desc>
            <Type>bool</Type>
            <Init>False</Init>

        </Output>

      </OutputList>
     </FBDD>
</FBDef>
```

Open \FBD\ directory and copy and paste one of existing FB Body files, change its name to IEC11313_SR.xml .change its content as following:

```
<?xml version="1.0"?>
<FBDef>
     <Version>1.0.0</Version>
     <FBDD>
          <Name>SR</Name>
          <Desc>SR Flip Flop</Desc>
          <Active>True</Active>
      <Interface></Interface>
      <InputList>
        <Input>
            <Name>S1</Name>
            <Desc>Set Input</Desc>
            <Type>bool</Type>
            <Init>False</Init>
        </Input>
        <Input>
            <Name>R</Name>
            <Desc>Reset Input</Desc>
            <Type>bool</Type>
            <Init>False</Init>
        </Input>

      </InputList>
      <OutputList>
        <Output>
            <Name>Q1</Name>
            <Desc>Q1 Output</Desc>
            <Type>bool</Type>
            <Init>False</Init>

        </Output>

      </OutputList>
     </FBDD>
</FBDef>
```

In this stage you can use IEC11313 group in SoftLogic Editor. Close FBEditor and run it again.

You can see a new IEC11313 group is added to FBEditor and it has two Function Blocks.



Drag and drop RS and SR Flip flops in a new application. RS and SR Flip Flops are ready to use in any Function block application.

10 – 2 Lua UDF Development

Lua scripting language is developed at 1993 by Roberto Ierusalimschy , Walder Celes and Luiz Henrique at university of PUC-Rio Brazil .(http://www.lua.org/authors.html) . For detail information about Lua , please refer to www.lua.org .

For quick Lua introduction, please visit http://www.inf.puc-rio.br/~roberto/talks/ppl-2012.pdf

In last 20 years Lua is used in many projects and devices:

TVs (Samsung), routers (Cisco), keyboards (Logitech), printers (Olivetti), set-top boxes (Verizon), M2M devices (Sierra Wireless), calculators (TI-Nspire), Wireshark, Snort, Nmap, VLC Media Player, LuaTeX

Adobe Lightroom One million lines of Lua code

Slashdot: News for nerds, Feb 1, 2012:

"Wikipedia Chooses Lua as its new template language "

Lua is used in many game development environments as programming framework:

Corona SDK – http://www.coronalabs.com/products/corona-sdk/
Gideros Studio – http://www.giderosmobile.com/
Moai – http://www.getmoai.com/
Love –https://love2d.org/
Codea – http://twolivesleft.com/

Lua is fast, small and very reliable. Lua is an active project and worldwide accepted as scripting language. So we selected Lua instead of ST as pbsSoftLogic scripting language for developing user defined Function blocks.
Lua Virtual machine is integrated to pbssoftlogic Linux Runtime kernel Version 1.5 and logic simulator. We didn't include Lua in pbsSoftLogic windows Runtime because you can develop UDF by C# and no need for Lua . We will use Lua for developing UDF for Linux based controllers and logic simulator.

When you use Lua for developing UDF, you don't need to use Linux cross compiler.
For developing Lua UDF you need to do following steps:

1 - Defining FB Input / Output structure – define UDF body. This step is same as C# /C UDF development.

2 – Write UDF script by pbsSoftLogic Lua Editor.

3 – Compile Lua source code for checking programming errors.

4 – Test Lua UDF by Logic simulator.

5 – Transfer Lua source code to controller.

We will compile Lua source code just for checking programming errors. We do not transfer compiler code to linux controller. When you transfer Lua UDF to controller, it will transfer Lua UDF source code.

pbsSoftLogic Linux controller , compiles Lua UDF source code when it load UDF.

10 – 2 Lua Language basics

Lua is dynamically typed language. There are eight basic type in Lua :

- Nil – no value , default value of a variable before initialization
- Boolean : has value false and true
- Number :double precision floating point
- String: sequence of characters. like “pbsSoftlogic”
- userdata (not used in pbsSoftlogic)
- thread (not used in pbsSoftlogic)
- table (will use for passing FB input outputs to Lua)

Tables are the main data structure in Lua . Look at following samples:

```
a = {} -- create a table and store its reference in 'a'
k = "x"
a[k] = 10 -- new entry, with key="x" and value=10
a[20] = "great" -- new entry, with key=20 and value="great"
print(a["x"]) --> 10
k = 20
print(a[k]) --> "great"
a["x"] = a["x"] + 1 -- increments entry "x"
```

In pbsSoftLogic we pass FB input output values by Table. In following figure you can see very simple pbsSoftLogic Lua function . You should follow same structure for your UDF:

```
function  fun3(Obji )

-- TmpPath , PID  , SRAMPath,SDPath are same for all FB . Do not delete them

    local Objo = {}

    TmpPATH =  Obji["1"]
    TmpPID = Obji["2"]
    TmpLogic = Obji["3"]
    TmpSRam = Obji["4"]
    TmpSD = Obji["5"]

     --read inputs
     in1 = tonumber(Obji["6"])
     in2 = tonumber(Obji["7"])

    -- define  output signals
     local out1 = 0
     local out2 = 0

     -- read Static data

     -- Solev logic

     --save static data

     -- write outputs
      Objo["1"] = tostring(out1)
      Objo["2"] = tostring(out2)

    return Objo
end
```

Obji = input table to FB. It contains all FB inputs. The first fifth element is used by pbsSoftlogic Linux kernel to pass following data to any UDF:

Obji["1"] = path of RAMDisk Drive in Linux Controller for saving static data . for example it is like "/mnt/ramdisk/" it include "/" .

Obji["2"] =unique Identifier of UDF .

Obji["3"] = name of program. In Linux Kernel it is always "logic"

Obji["4"] = SRAM address in controller . It is RAM with battery backup. It include "/"

Obji["5"] =SD address . It is External flash SD card address for data logging. It include "/"

Points:

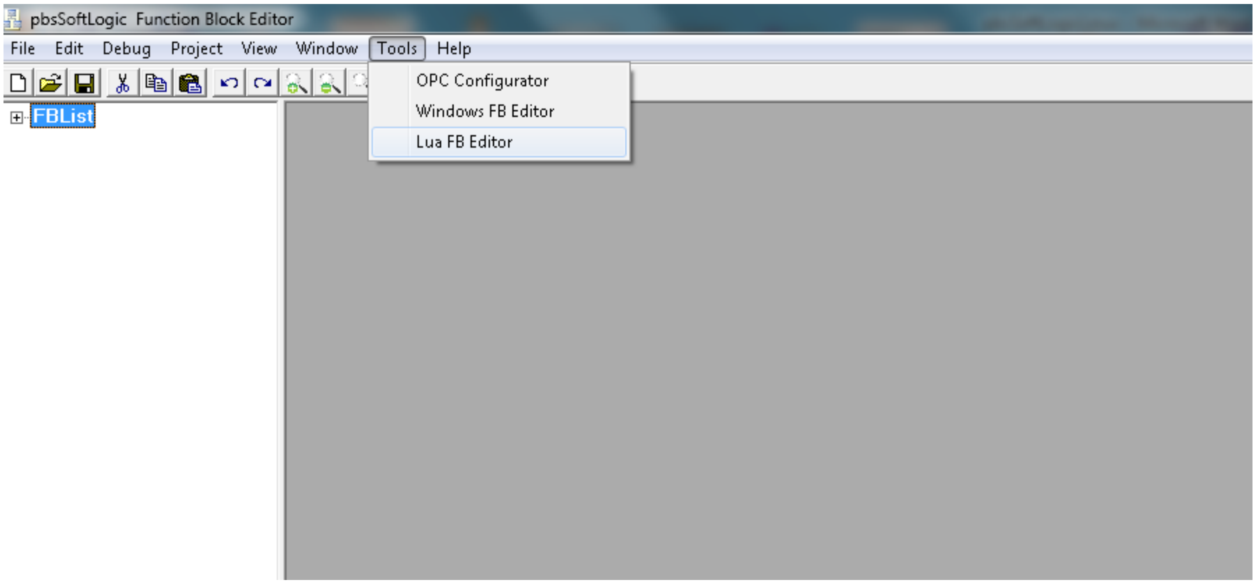
- UDF inputs start from key "6".
- All key value should be as string number: "1" ,"2" ,"3",…
- All inputs are pass as string to Lua . So you should change its type to number by tonumber function. Example in1 = tonumber(obji["6"]) . This is value of first UDF input.

objo is return table from Lua.

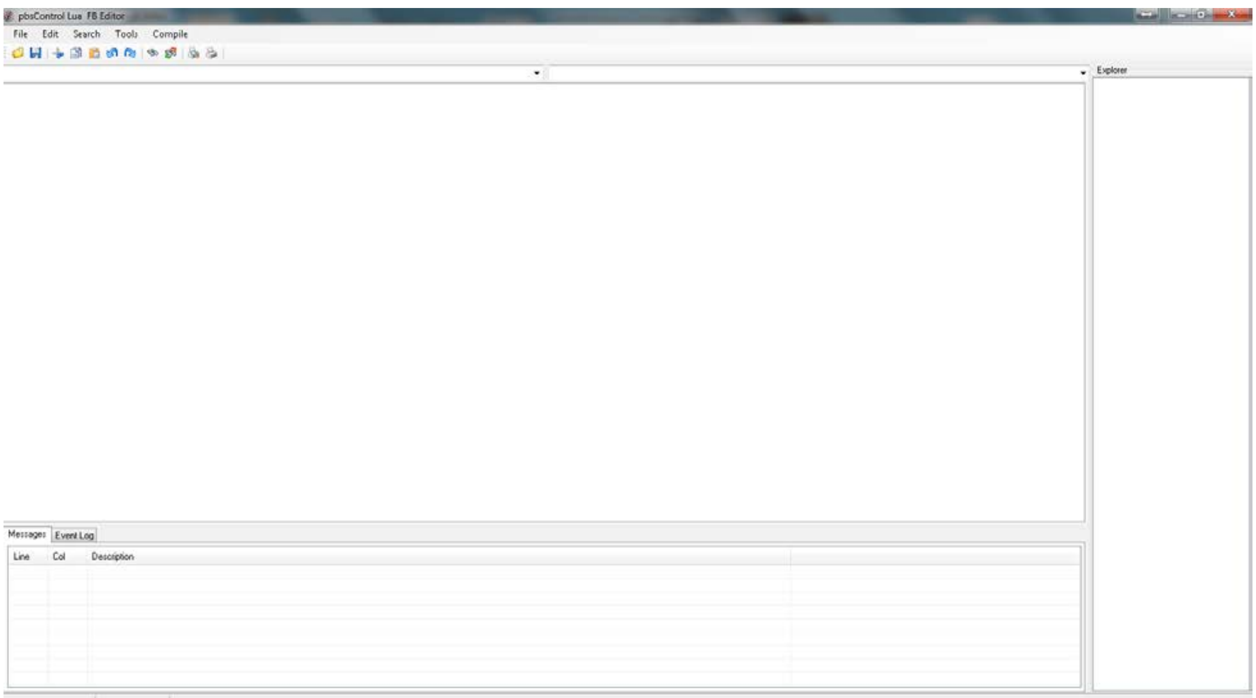
Points:

- objo key start from"1".
- objo["1"] = first UDF output
- objo["2"] = second UDF output
- objo["n"] = n'th UDF output n<32
- All values will return to pbsSoftlogic linux kernel by string format by tostring function .
- objo["1"] = tostring(out1)
- Last statement in Lua should be return objo .

pbsSoftLogic included Lua editor . Open Lus editor from tools menu.



Run Lua FB editor. You can see following environment:



- Source code of Lua UDF is at \PSLE\LuaSrc directory.

You can define Lua functions and Lua Function Blocks in pbsSoftLogic .

Lua Function: Function Without static data.

Lua Function Block: Function With Static data.

In Lua FB Editor , execute “New Lua Function” from File menu . It will make NewLuaFun.Lua file at \PSLE\LuaSrc directory .

Lua FB Editor will make NewLua_Fun function as template for Lua Functions:

```
function  NewLua_Fun(Obji)
    -- Lua Function = Function without static data . There is no memory in function code.
    local Objo = {}
    --Define Output Variables
    local out1=0
    local out2=0
    --add more output variables  here
    --Define Intrnal Variables
    --Read Input variables
   Input1 = tonumber(Obji["6"])
   Input2 = tonumber(Obji["7"])
    --add more input variables here
   --Solve Logic
   --Write your logic here
   out1 = Input1 + Input2
   out2 = Input1 - Input2
   --Write outputs
   Objo["1"] = tostring(out1)
   Objo["2"] = tostring(out2)
   return Objo
end
```

There is no memory in Lua Functions. Input signals will pass to function and output values will calculate based on current value of inputs.

At following figure, we calculate (x^2 + Y^2)^0.5

```
function fun3(Obji)
    -- Lua Function = Function without static data . There is no memory in function code.
    local Objo = {}
    --Define Output Variables
    local L=0
    --add more output variables  here
    --Define Intrnal Variables
    --Read Input variables
   X = tonumber(Obji["6"])
   Y = tonumber(Obji["7"])
    --add more input variables here
   --Solve Logic
   --Write your logic here
   L = (X ^2 + Y^2)^0.5
   --Write outputs
   Objo["1"] = tostring(L)
   return Objo
end
```

In Lua FB Editor, execute “New Lua Function Block” from File menu. It will make NewLuaFB.Lua file at \PSLE\LuaSrc directory.

Lua FB Editor will make NewLua_FB function as template for Lua Function block:

```
function  NewLua_FB(Obji)
    -- Lua Function Block = Function   with static data . There is  memory in function Block code.
    local Objo = {}
    -- TmpPath , PID ,VSLEName , SRAMPath,SDPath are same for all FB . Do not delete them
   TmpPath  = Obji["1"]
   PID      = Obji["2"]
   VSLEName = Obji["3"]
   SRAMPath = Obji["4"]
   SDPath   = Obji["5"]
    --Define Output Variables
    local out1=0
    local out2=0
    --add more output variables  here
    --Define Intrnal Variables
    local state=0 -- this is static signal . so we will keep its last value in FB memory block
    local  dt=0
    local  input1old = 0
    --Read Input variables
   Input1 = tonumber(Obji["6"])
   Input2 = tonumber(Obji["7"])
    --add more input variables here
    --Read Static data
```

In this Lua FB sample, we consider following variables:

- Two output signal – ou1 , out2
- Three static signal – state , dt , input1old
  - State shows current state of FB.
  - dt is date time signal . In Lua os.time() function returns seconds from 1/1/1970 . When you compare current time with dt , it shows seconds passed from dt .
  - input1old is used for detecting rising edge of input1 signal .

```
     --Read Static data
    local fr  = io.open(TmpPATH .. "NewLua_FB_" .. TmpPID  .. "_" .. TmpLogic ..  ".dat" ,"r")
    if fr ~=nil then
        while true do
            line = fr:read()
                if line ~= nil then
                    i ,j =string.find(line,"=")
                    n = string.sub(line,1,j-1)
                    if n == "state" then
                        state = tonumber(string.sub(line,j+1))
                    end
                    if n == "dt" then
                        dt = tonumber(string.sub(line,j+1))
                    end
                    if n == "input1old" then
                        input1old = tonumber(string.sub(line,j+1))
                    end
                    -- add more static variables here
                    -- if n == "varstatic1" then
                    --              varstatic1 = tonumber(string.sub(line,j+1))
                    -- end
                    if n == "out1" then
                        out1 = tonumber(string.sub(line,j+1))
                    end
                    if n == "out2" then
                        out2 = tonumber(string.sub(line,j+1))
                    end
                    -- All Output Variables should be Static
                    -- if n == "out3" then
                    --              out3 = tonumber(string.sub(line,j+1))
                    -- end
                else
                    break
                end
        end
    fr:close()
    end
```

In pbsSoftlogic static data is simulated by a data file In Controller ram disk.

If Logic scan time is set to 500 msec , then every second , whole logic will execute for two times .

For each function block we have one static data file which is located on ram disk.

Because static data files are located on ram disk, so continues read /write of static data files will not make damage on controller and we will not lose system performance.

Static data file name is generated from function Block name, function block unique ID and logic name.

Function Block Unique ID – TmpPID - and Logic name – TmpLogic - are passed by pbsSoftLogic Linux kernel to function block. In Static data file name, you need to change function block name to your UDF name. For above FB, Static data file is as following figure:

```
state=0
dt=1379658085
input1old=0
out1=0
out2=0
```

We read static data file, line by line and find value of static signals and initialize static data tags at beginning of FB.

Always consider output signals as static and save their values in static data file. Normally output signals are not calculated in function block at each cycle, so you need to use old value of output signals in current cycle.

```lua
    --Solve Logic
    --Write your logic here
    if Input1 ==1 and input1old ==0 then
        dt = os.time()     -- save start time here
        state = 1
    end
    if Input1 ==0 and input1old ==1 then
        state = 0
    end
    if state ==1 then
        if os.time() -dt< 10  then  -- compare current time with start time ,
            out1 = 1
            out2 = Input2
        else
            out1 = 0
            out2 = 0
        end
    else
        out1 = 0
        out2 = 0
    end
    input1old = Input1
    --Save Static data
    local fw  = io.open(TmpPATH .. "NewLua_FB_" .. TmpPID  .. "_" .. TmpLogic ..  ".dat" ,"w")
    fw:write("state=" .. tostring(state) .. "\n")
    fw:write("dt=" .. tostring(dt) .. "\n")
    fw:write("input1old=" .. tostring(input1old) .. "\n")
    fw:write("out1=" .. tostring(out1) .. "\n")
    fw:write("out2=" .. tostring(out2) .. "\n")
    fw:close()
    --Write outputs
    Objo["1"] = tostring(out1)
    Objo["2"] = tostring(out2)
    return Objo
end
```

After reading input signals and static tags, you need to solve your logic.

Always remember that your logic is executing many times in a second.

For detecting rising edge or falling edge of a signal, you need to compare current value of signal with value of signal at last cycle.

```
if Input1 ==1 and input1old ==0 then
    dt = os.time()     -- save start time here
    state = 1
end
```

Input1 is current value of signal and input1Old is last value of signal.

At end of function block, always you need to map current value of signal to old value.

```
input1old = Input1
```

Normally function block is in a specific state at each cycle. So you need to define state static tag and set its value by input signal changes or internally in the function block. In above example when there is rising edge at Input1 signal, we will set state to 1 and will save time by os.time() function . os.time() returns current time from 1/1/1970 in seconds .

In following code, when Inut1 signal has falling edge, FB will go to state zero.

```
if Input1 ==0 and input1old ==1 then
    state = 0
end
```

In following code, when FB is in state one, it will map Input2 to out2 and sets out1 to 1 for 10 seconds. If before 10 seconds, falling edge detecting for Input1 signal, FB goes to state 0.

```
if state ==1 then
    if os.time() -dt< 10  then  -- compare current time with start time ,
        out1 = 1
        out2 = Input2
    else
        out1 = 0
        out2 = 0
    end
else
    out1 = 0
    out2 = 0
end
```

For calculating elapsed time always use above technique.

After solving your logic, you need to save static data and write output signals.

Lua expression from programming in Lua 3ed written by Roberto ierusalimschy :

Lua supports the usual arithmetic operators: the binary '+' (addition), '-' (subtraction),'*' (multiplication), '/' (division), '^' (exponentiation), '%' (modulo), and the unary '-' (negation). All of them operate on real numbers. For instance, x^0.5 computes the square root of x, while x^(-1/3) computes the inverse of its cubic root.
The following rule defines the modulo operator:
a % b == a - math.floor(a/b)*b For integer operands, it has the usual meaning, with the result always having the same sign as the second argument. For real operands, it has some extra uses. For instance, x%1 is the fractional part of x, and so x-x%1 is its integer part. Similarly, x-x%0.01 is x with exactly two decimal digits:
x = math.pi
print(x - x%0.01) --> 3.14

Lua provides the following relational operators:
< > <= >= == ~=
All these operators always produce a boolean value.

The == operator tests for equality; the ~= operator is the negation of equality. We can apply both operators to any two values. If the values have different types, Lua considers them not equal. Otherwise, Lua compares them according to their types. Specifically, nil is equal only to itself.

The logical operators are **and**, **or**, and **not**. Like control structures, all logical operators consider both the boolean **false** and nil as false, and anything else as true. The **and** operator returns its first argument if it is false; otherwise, it returns its second argument. The **or** operator returns its first argument if it is not false; otherwise, it returns its second argument:

print(4 and 5) --> 5
print(nil and 13) --> nil
print(false and 13) --> false
print(4 or 5) --> 4
print(false or 5) --> 5

Both **and** and **or** use short-cut evaluation, that is, they evaluate their second operand only when necessary. Short-cut evaluation ensures that expressions like (type(v)=="table"and v.tag=="h1") do not cause run-time errors: Lua will not try to evaluate v.tag when v is not a table.

A useful Lua idiom is x=x or v, which is equivalent to if not x then x = v end That is, it sets x to a default value v when x is not set (provided that x is not set to **false**).

Another useful idiom is (a and b)or c, or simply a and b or c, because **and** has a higher precedence than **or**. It is equivalent to the C expression a?b:c, provided that b is not false. For instance, we can select the maximum of two numbers x and y with a statement like max = (x > y) and x or y When x>y, the first expression of the **and** is true, so the **and** results in its second expression (x), which is always true (because it is a number), and then the **or** expression results in the value of its first expression, x. When x>y is false, the **and** expression is false and so the **or** results in its second expression, y.
The **not** operator always returns a boolean value:
print(not nil) --> true
print(not false) --> true
print(not 0) --> false
print(not not 1) --> true
print(not not nil) --> false

Lua denotes the string concatenation operator by .. (two dots). If any operand is a number, Lua converts this number to a string.

Operator precedence in Lua follows the table below, from the higher to the lower priority:

```
^
not # - (unary)
* / %
+ -
..
< > <= >= ~= ==
and
or
```

All binary operators are left associative, except for ‘^’ (exponentiation) and ‘..’ (concatenation), which are right associative. Therefore, the following expressions on the left are equivalent to those on the right:

```
a+i < b/2+1 <--> (a+i) < ((b/2)+1)
5+x^2*8 <--> 5+((x^2)*8)
a < y and y <= z <--> (a < y) and (y <= z)
-x^2 <--> -(x^2)
x^y^z <--> x^(y^z)
```

Assignment is the basic means of changing the value of a variable or a table field:

```
a = "hello" .. "world"
t.n = t.n + 1
```

Lua allows multiple assignment, which assigns a list of values to a list of variables in one step. Both lists have their elements separated by commas. For instance, in the assignment

```
a, b = 10, 2*x
```

if then else

An **if** statement tests its condition and executes its then-part or its else-part accordingly. The else-part is optional.

```
if a < 0 then a = 0 end
if a < b then return a else return b end
if line > MAXLINES then
   showpage()
   line = 0
end
```

while

As the name implies, a **while** loop repeats its body while a condition is true. As usual, Lua first tests the **while** condition; if the condition is false, then the loop ends; otherwise, Lua executes the body of the loop and repeats the process.

```
local i = 1
while a[i] do
  print(a[i])
  i = i + 1
end
```

Numeric for

The **for** statement has two variants: the numeric **for** and the generic **for**.
A numeric **for** has the following syntax:

```
for var = exp1, exp2, exp3 do
	<something>
end
```

This loop will execute something for each value of var from exp1 to exp2, using exp3 as the step to increment var. This third expression is optional; when absent, Lua assumes 1 as the step value. As typical examples of such loops, we have

```
for i = 1, f(x) do print(i) end

for i = 10, 1, -1 do print(i) end
```

If you want a loop without an upper limit, you can use the constant math.huge:

```
for i = 1, math.huge do
	if (0.3*i^3 - 20*i^2 - 500 >= 0) then
		print(i)
		break
	end
end
```

Writing C code for Linux and cross compiling of UDF

You can develop your UDF by C Language too . Developing UDF by C has advantage and disadvantage.

Advantage : Performance of UDF with C Language is better than Lua Scripting .

Disadvantage : you should compile your UDF for each RTU and Operating systems .

For RTUs which is running Debian Based OS , you can compile UDF directly on the RTU .

But for RTUs without gcc , you need to use cross compiler to compile UDF .

For cross compiling for embedded linux you need to have following software's:

1 – Ubuntu Linux distribution. You can download from http://www.ubuntu.com/download/desktop

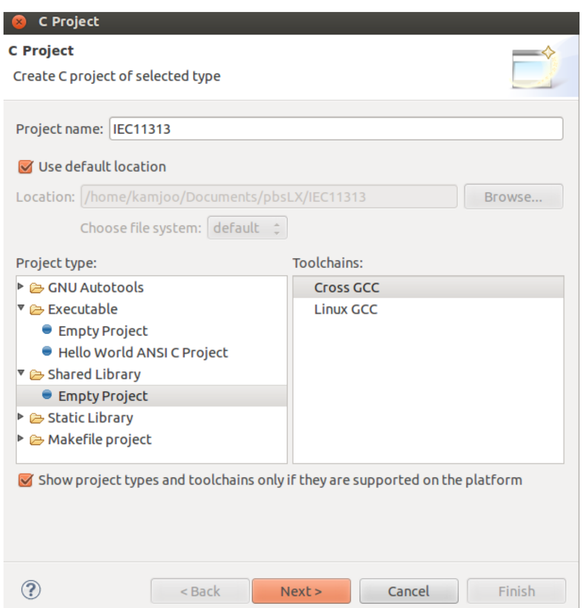
2 – Install ubuntu on a Virtual Machine like VMWare , or install it on a PC .

3 – Download eclipse IDE from http://www.eclipse.org/downloads/ and download Eclipse IDE for C/C++ Developer for linux 32 or 64 bit .

4 – Cross Compiler for your RTU .

You can find source code of all pbsSoftLogic at c:\PSLE\CSrc directory.

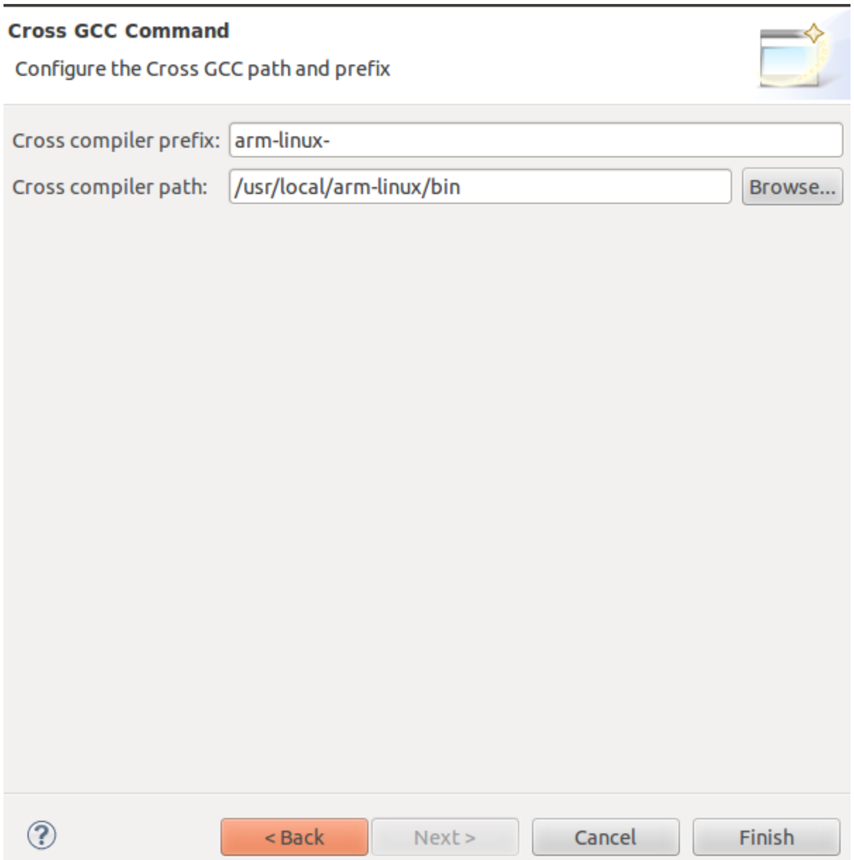
Open eclipse IDE and make a new C Project. Project name should be exactly same name of UDF group, for our example "IEC11313"



Project Type: Share Library

Toolchain : Cross GCC

Click on Next.



Set Cross Compiler prefixes and cross compiler path as above figure.

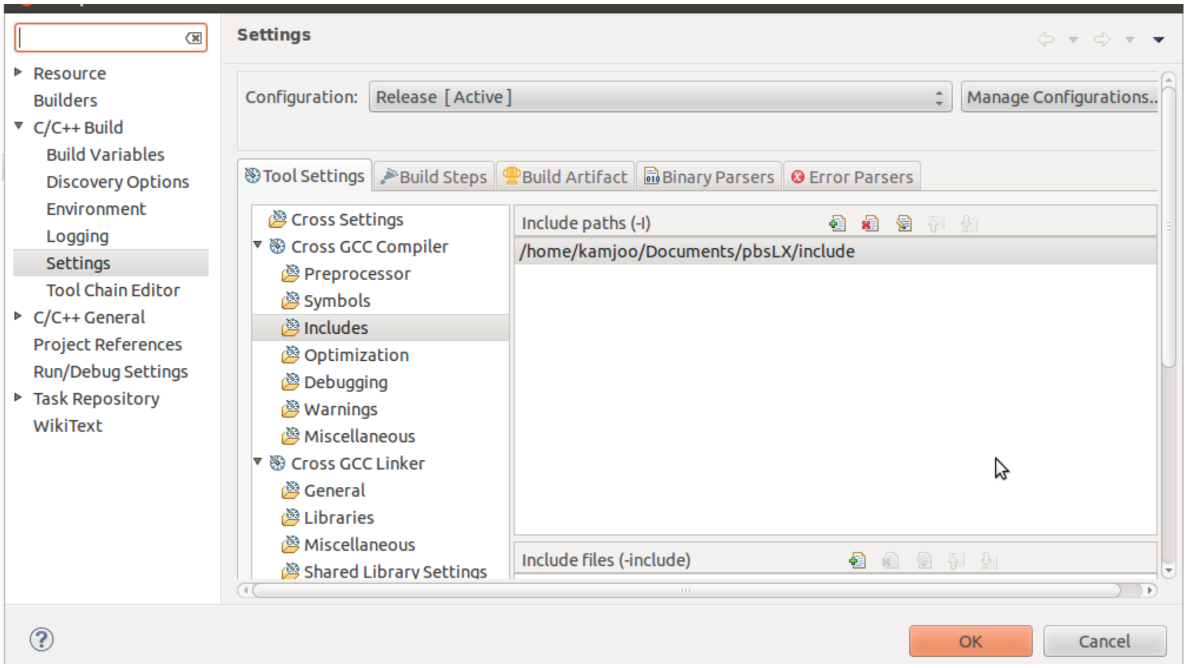
Click on finish button.

Copy paste one of existing source code from CSrc directory to new project directory .

Suppose you will copy counter source file (MainCounters.c) to IEC11313 directory . Rename MainCounters.c to MainIEC11313.c .

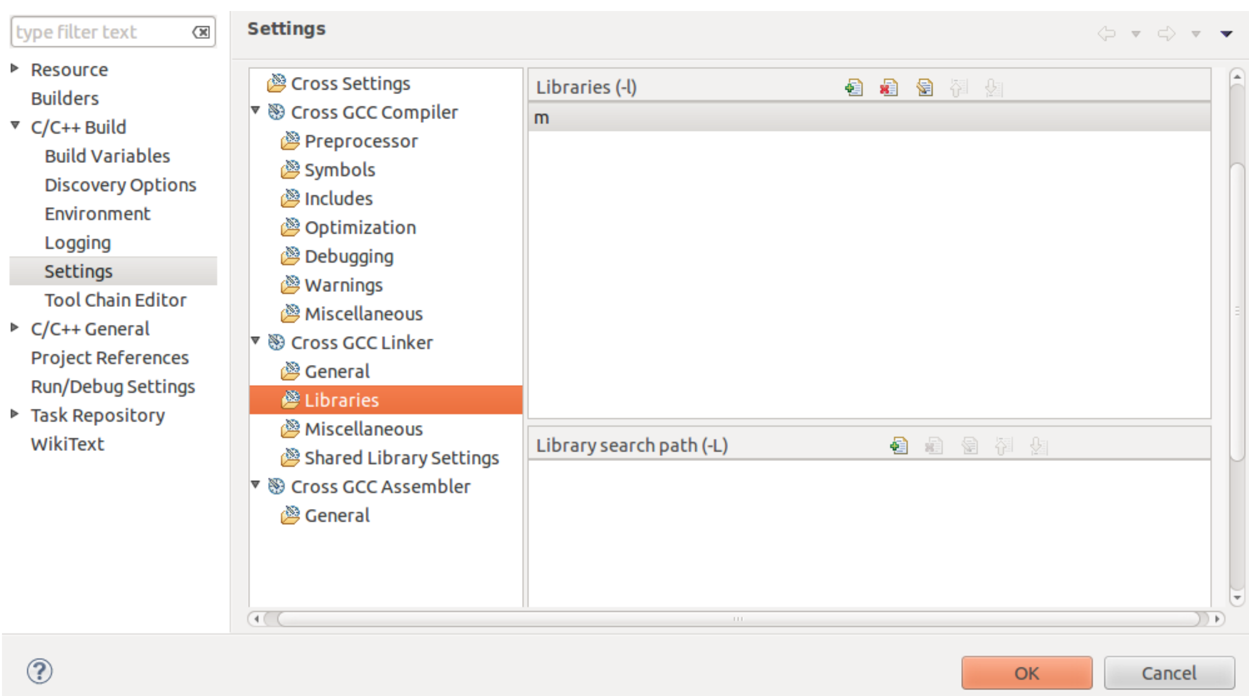
Select IEC11313 project in eclipse and refresh project to include MainIEC11313.c file to project .

There is include directory in CSrc folder that need to be included to IEC11313 project . open project properties in eclipse and add Include directory path to project .

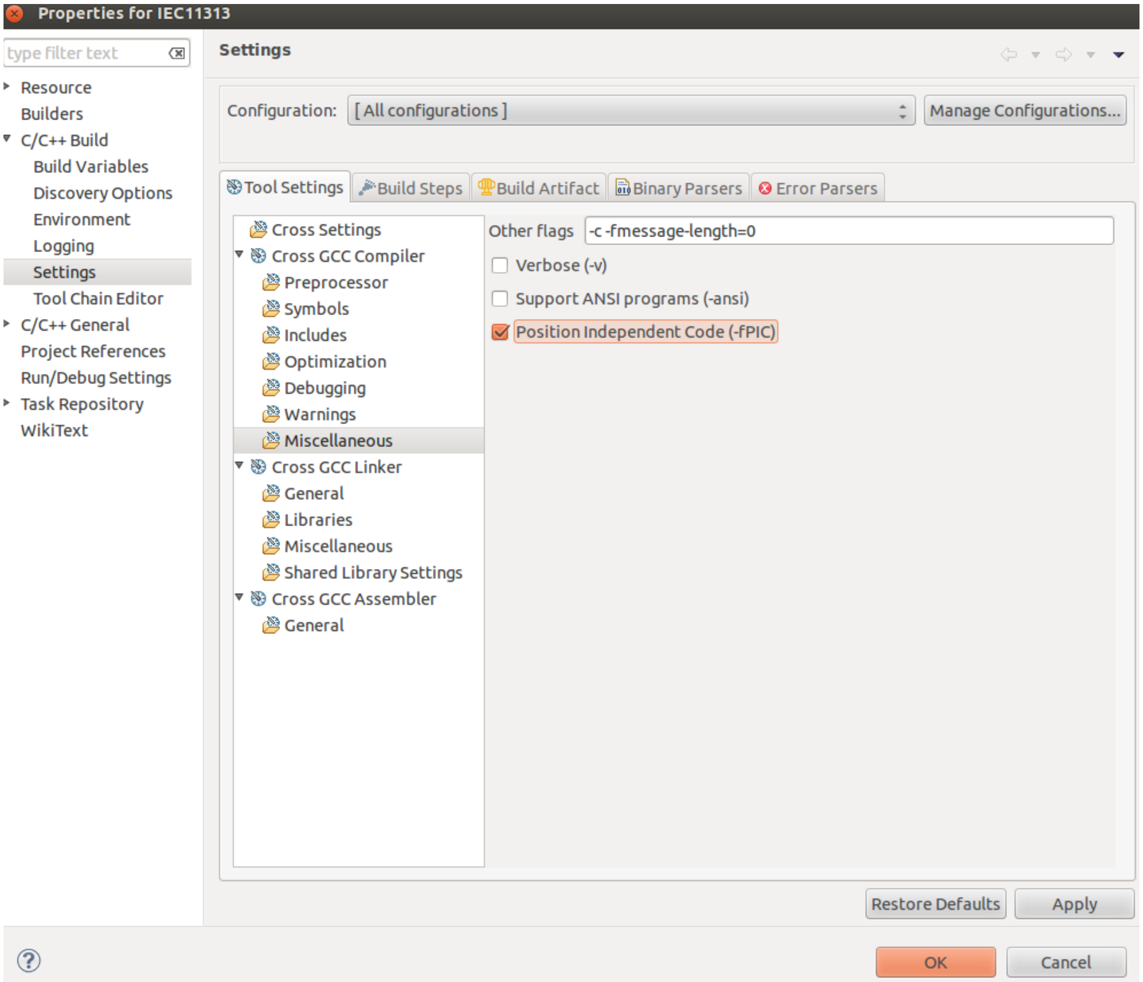


Select release mode as active mode in manage configuration. Add include directory for Debug and release configuration.

If you use GCC mathematical library in UDF , you need to add m library to project .



In project settings /Miscellaneous enable Position Independent Code –PIC .



Open MainIEC11313.c source code in eclipse. Change name of UpCounter functions to RS and DownCounter function to SR.

Any C FB has following format:

```
void RS(pbsObject *  Obji, pbsObject  * Objo)
```

Don't change function format and just change name of function to SR and RS.

obji is list of all inputs to function .

objo is list of all FB outputs .

In Linux kernel first FB input is passed by index 5 of obji . int S = Obji[5].dvalue;

```
void RS(pbsObject *  Obji, pbsObject  * Objo)
{
	char  TmpPath[64] ;
	char PID[32];
	char ProgName[32];
	char  TmpSRamPath[64] ;
	char TmpSDPath[64];



	int S = Obji[5].dvalue;
	int R1 = Obji[6].dvalue;
```

Index 0 to 4 is used for passing system data for reading /writing static data.

```
	strcpy(TmpPath , Obji[0].strvalue);
	strcpy(PID , Obji[1].strvalue);
	strcpy(ProgName , Obji[2].strvalue);

	strcpy(TmpSRamPath , Obji[3].strvalue);
	strcpy(TmpSDPath ,Obji[4].strvalue);

	// Read Static data

	FILE * m_db ;
	DBStruct db_elem;
	char TmpStaticDataPath[128];
	strcpy(TmpStaticDataPath,TmpPath);
	strcat(TmpStaticDataPath,"/RS_");
	strcat(TmpStaticDataPath,ProgName);
	strcat(TmpStaticDataPath,"_");
	strcat(TmpStaticDataPath,PID);
	strcat(TmpStaticDataPath,".dat");
```

Reading Static data:

```
m_db = fopen(TmpStaticDataPath, "rb");
if(m_db==NULL)
{
	// first time generate this file . User default value for static  data

}
else
{
	// Read Value of static data
	while (feof(m_db)==0)
	{
		fread(&db_elem, sizeof(db_elem), 1, m_db);
		if(strcmp(db_elem.name ,"SOld")==0)
		{
			SOld = atoi(db_elem.value);

		}
		if(strcmp(db_elem.name ,"R1Old")==0)
		{
			R1Old = atoi(db_elem.value);

		}

		if(strcmp(db_elem.name ,"Q1")==0)
		{
			Q1 = atoi(db_elem.value);
		}


	}
	fclose(m_db);
}
```

In RS FB, old status of S, R 1 and Q1 value should be static.

You need to make all outputs in FB with static data as static tags.

Solve logic , map old values and write outputs :

```
if((S==1)&&(SOld==0))
{
        Q1 = 1;
}

if((R1==1)&&(R1Old==0))
{
        Q1 = 0;
}


Objo[0].dvalue = Q1;

// Map New Static data to old one
SOld = S;
R1Old = R1;
```

Write static data :

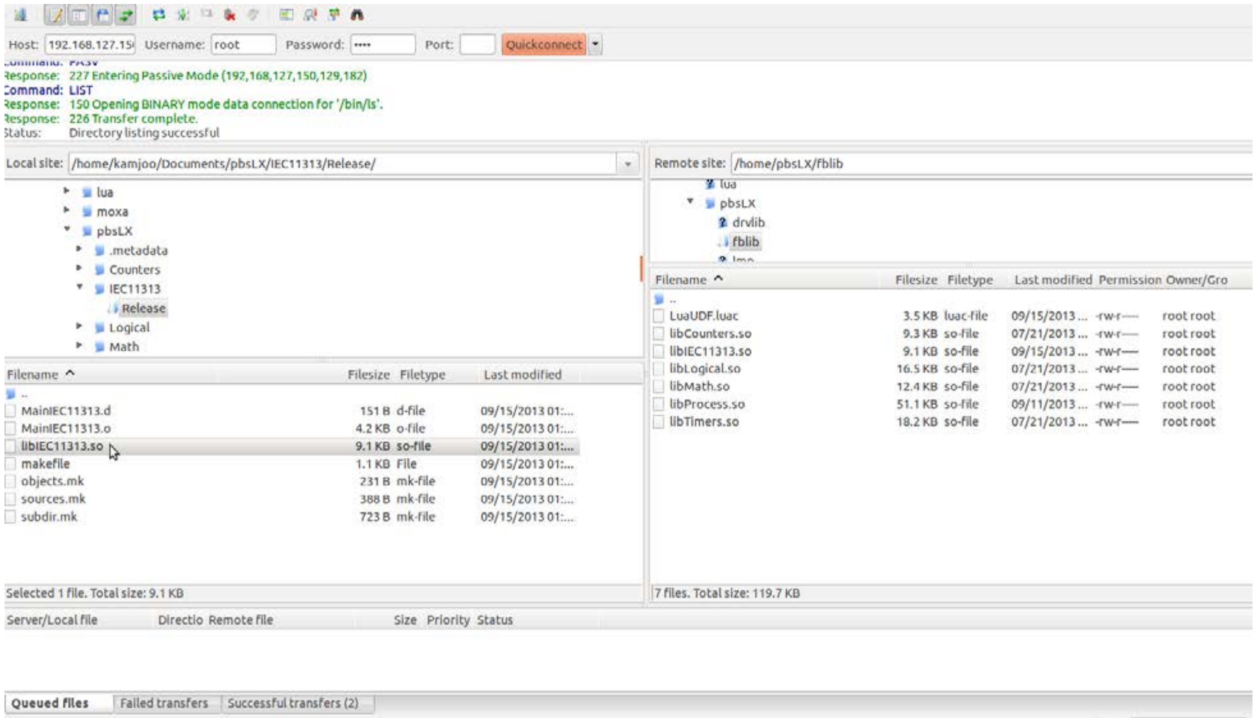
```
// Save Static data
        m_db = fopen(TmpStaticDataPath, "wb");




        strcpy(db_elem.name,"SOld");
        sprintf(db_elem.value,"%d",SOld);
        fwrite(&db_elem, sizeof(db_elem), 1, m_db);


        strcpy(db_elem.name,"R1Old");
        sprintf(db_elem.value,"%d",R1Old);
        fwrite(&db_elem, sizeof(db_elem), 1, m_db);


        strcpy(db_elem.name,"Q1");
        sprintf(db_elem.value,"%d",Q1);
        fwrite(&db_elem, sizeof(db_elem), 1, m_db);


        fclose(m_db);
```

In this stage you can compile FB. Eclipse will make libIEC11313.so file at release directory.

You should copy this file to controller. /home/pbsLX/fblib directory .

You can use filezilla for transferring libIEC11313.so file to controller.

Please notice that transfer mode must be Binary in Filzilla .



Compiling UDF on Debian based RTUs :

When you make your UDF in previous step by Eclipse , it will make automatically all necessary make files . You can use same files or make a new project based on Linux GCC (Not Crossed GCC) in Ubuntu .

If you use same Cross compiling project for debian you need to remove all prefixes about your Cross compiler from make files transfer project to debian and make UDF by make command .

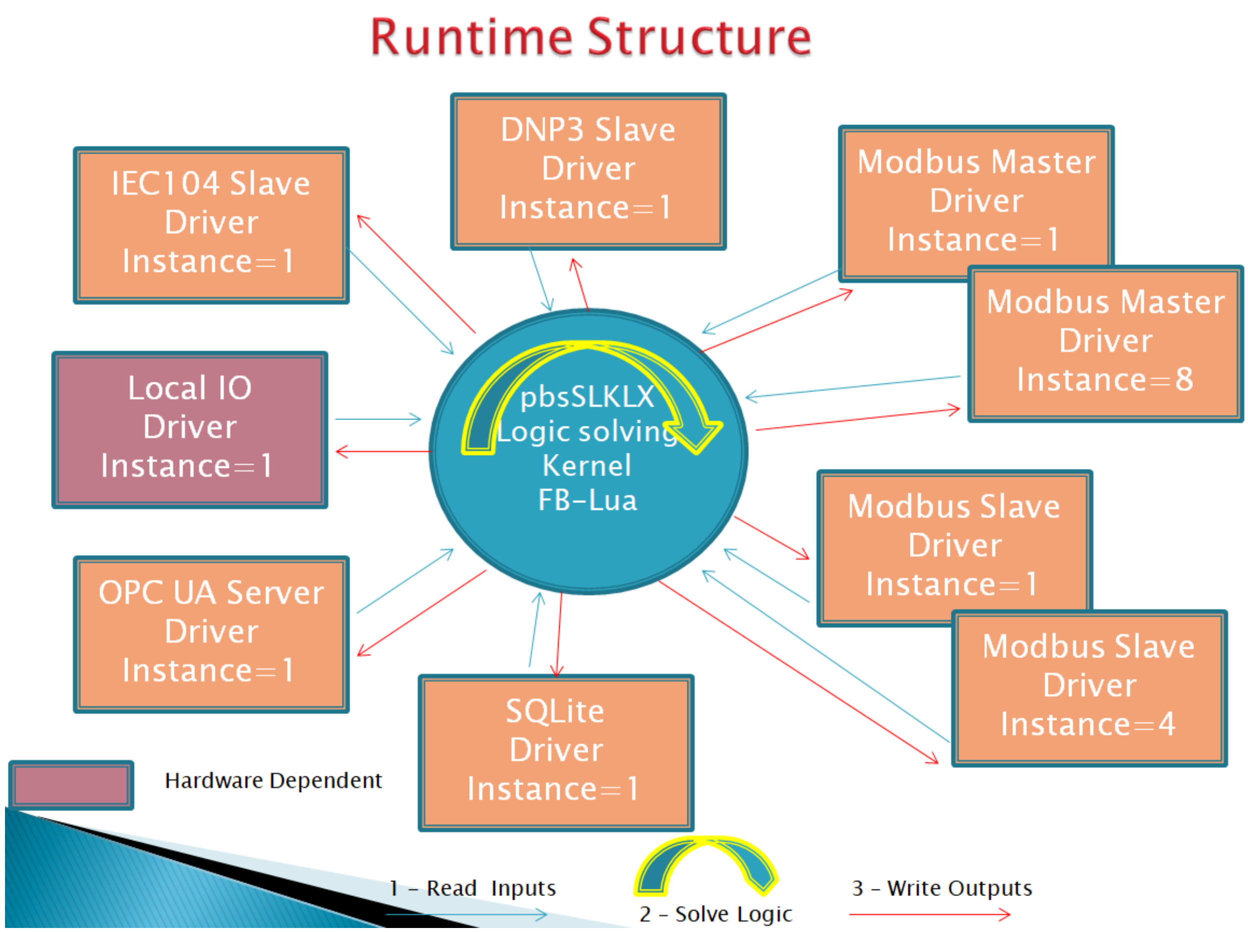
11 – Runtime Kernel for Linux, transferring License to Controller and working with Linux

In this chapter will talk about runtime structure of pbsSoftLogic inside RTU . pbsSoftLogic runtime kernel is based on very simple concept .

pbsSLKLX : this is main application in linux which will start automatically when RTU is booted or you can load it manually for Diagnostic purpose .

Communication Drivers: Different communication drivers which are supported by pbsSoftLogic .

In following figure you can see how above components are communicating with each other.



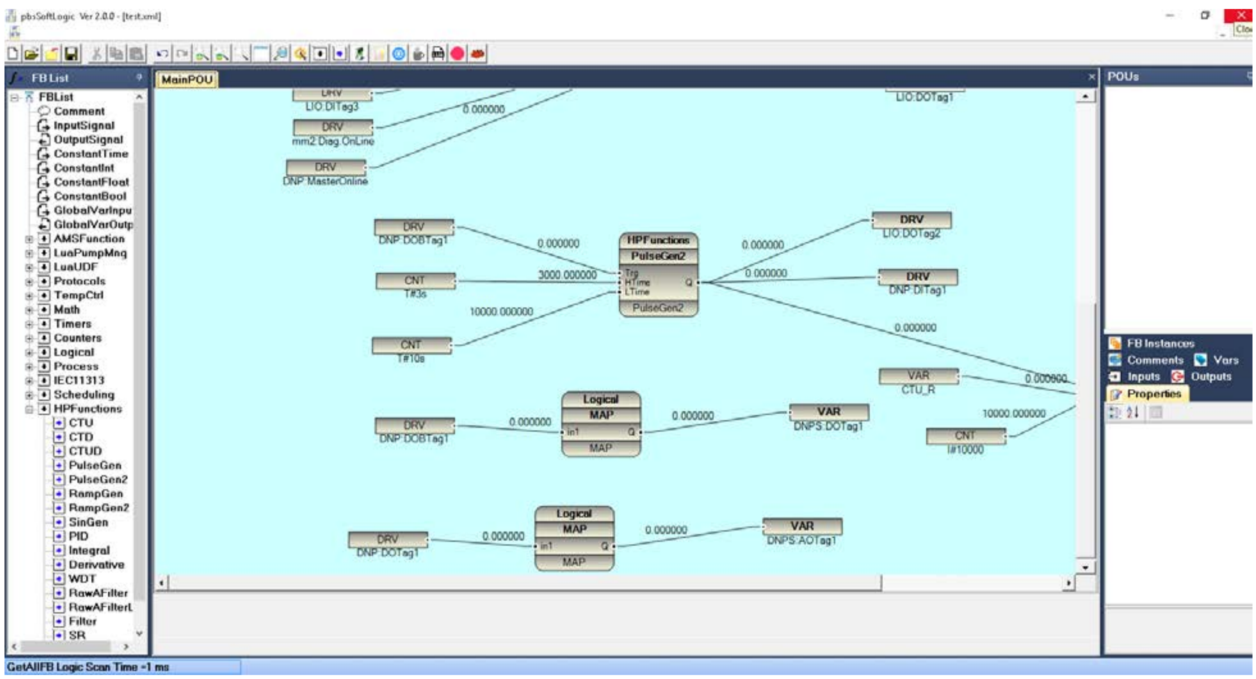
When you run pbsSLKLX following steps will done in RTU :

- 1- pbsSLKLX will load /home/pbsLX/logic.cfg file . This file contains all defined communication protocol for active project.
- 2 - pbsSLKLX will load communication driver library in to memory dynamically .

- 3 - pbsSLKLX get Driver parameters from logic.cfg file and pass one by one to Communication Driver library
- 4 - pbsSLKLX will add Communication Blocks , Slots and Finally Driver Tags
- 5 - pbsSLKLX will call pbsInit Function to initialize Communication Driver
- 6 - pbsSLKLX will repeat steps 2 , 3, 4, 5 for all defined drivers in logic.cfg
- 7 - pbsSLKLX will start to read input Tags for all Communication Drivers by calling pbsReadTag
- 8 - pbsSLKLX solve one time RTU logic
- 9 - pbsSLKLX will write to Communication Drivers all Output Tags by calling pbsWrite method .
- 10 – Repeat Steps 7 , 8 , 9

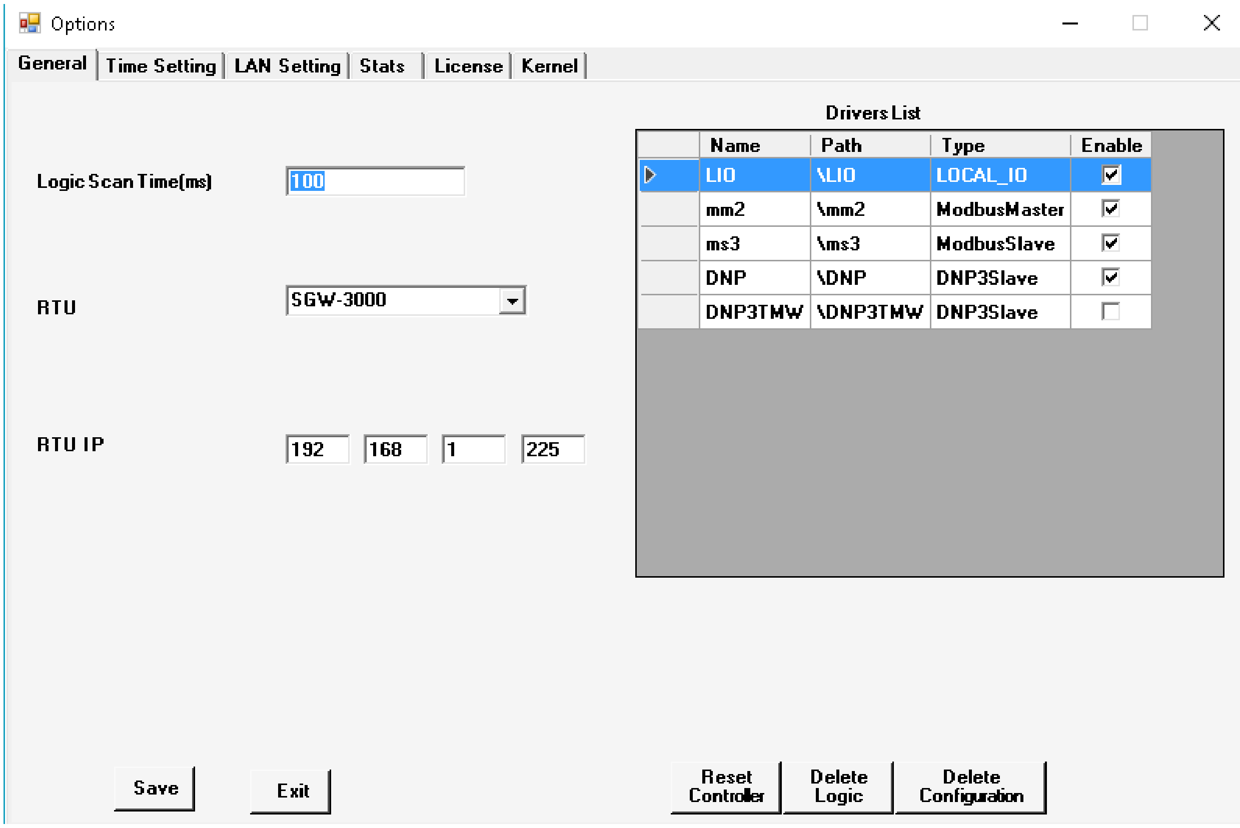
As it clear from above sequence, Communication Drivers has unified API interface for communication with pbsSLKLX .

Duration time for executing steps 7 , 8 , 9 is RTU Real Logic Scan Time . You can see Real Logic Scan Time when you connect to RTU by pbsSoftLogic Engineering . Real Logic Scan Time is shown in bottom of page at left side. In following figure Real Logic Scan time is 1 mse.



You couldn't control Real Logic Scan Time , but you can set Logic Scan Time in Project Setting Page .

For above sample Logic Scan Time is 100 msec .



It means every 100 msec , RTU will Read All Defined Driver Inputs (Step 7) , Execute Logic (Step 8) and Write all Define Driver Outputs (Step 9) . Time for executing Step 7 , 8 ,9 is 1 Msec . So pbsSLKLX CPU thread is at sleep for 99 msec .

pbsSLKLX has only one thread for Reading Driver Input Tags , Execute RTU logic and Write Driver Output Tags . But there is no any limitation in Drivers Library to get many CPU threads.

When you reduce Logic Scan Time and make it close to Real Logic Scan Time , then RTU CPU Usage will increase . So you should select Logic Scan Time Based on your Process Condition and it should be always more than Real Logic Scan Time.

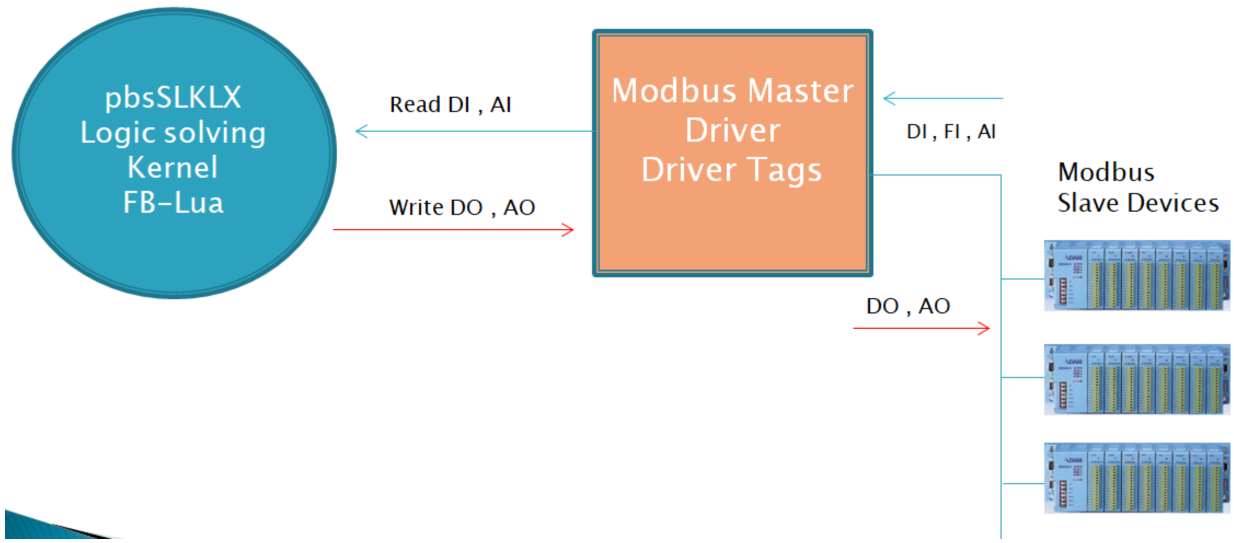
You can use less than 1 mse for logic scan time , 0.1 or 0.01 msec is also possible to Set .

Please notice that pbsSLKLX Scan Time is different than Communication protocol scan time. You can Read Modbus Slaves every second , but pbsSLKLX will read/write to driver tags every 10 msec as an example .

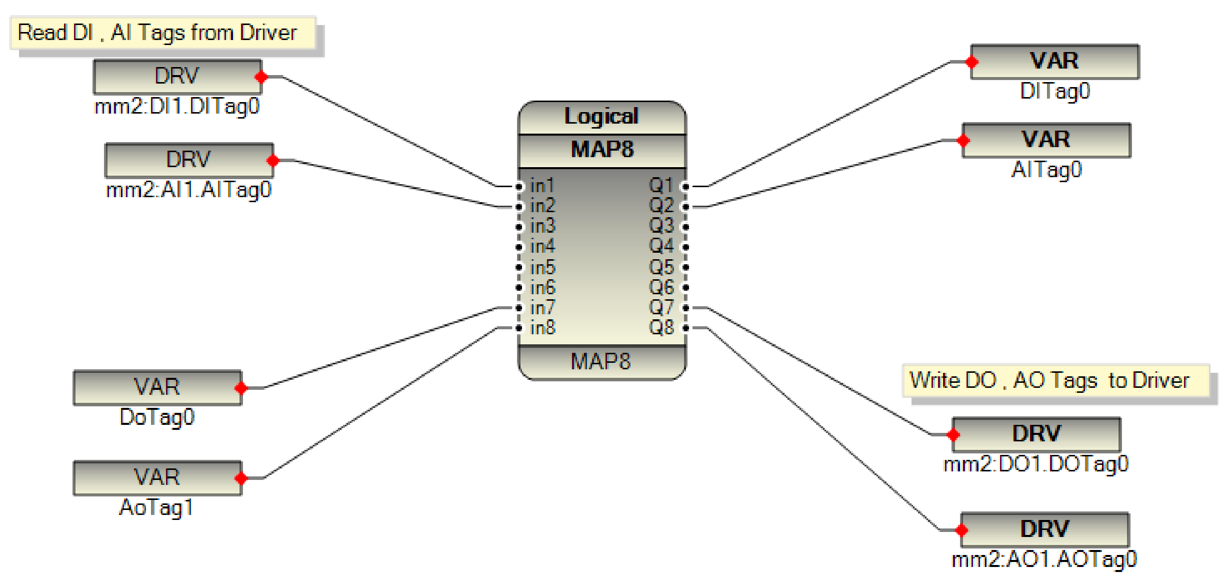
Slave and Master Drivers : There is a conceptual difference in Master Drivers Like Modbus TCP/RTU Master , IEC101 /103 Master and slave drivers like Modbus TCP/RTU Slave , DNP3 Slave , IEC101/104 Slave .

Master Drivers : In following figure you can see Modbus Master Driver is reading Digital and Analog Inputs from Slave devices and Write Digital and Analog Output to Slave devices .

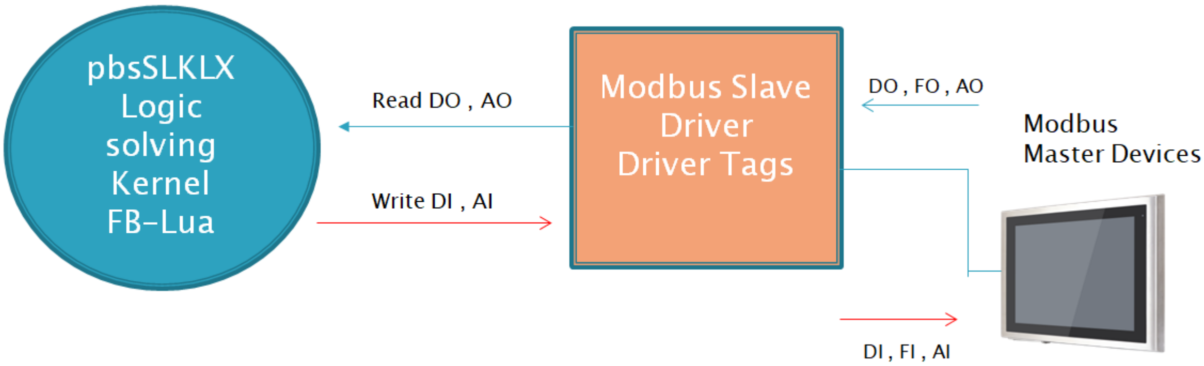
pbsSLKLX is Reading input Digital and Analog Tags from Driver and Write Output Digital and Analog Tags to Driver .



In RTU Logic you should use Input Tags in Left Side of Function Blocks to read from driver and use Output Tags in Right Site of Function Blocks to Write to Driver .

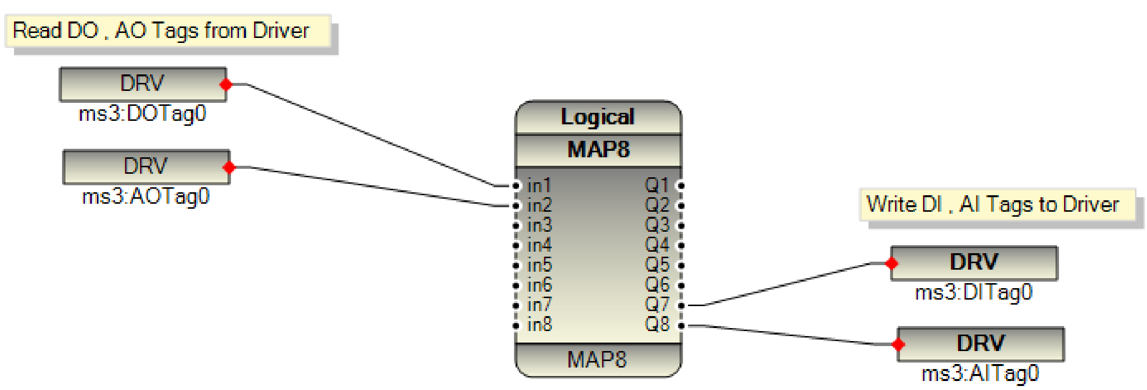


Slave Drivers: In following figure you can see Modbus Master Devices (HMI Panel, SCADA Software's) are read Digital and Analog Tags from Modbus Slave Driver and Write Digital and Analog Output Tags to Modbus slave driver.



pbsSLKLX is Writing Digital and analog Tags to Modbus Slave Driver (you will update by RTU Logic Modbus Slave DI , AI Tags for reading by Modbus Master Device) and pbsSLKLX is read Digital and Analog Outputs from Modbus Slave Driver . These Tags are written by external Modbus Master Device to Modbus Slave Driver.

In Slave Drivers , you Should use DO , AO tags (Read From Driver) in Left Side of Function Blocks and DI , AI Tags (Write to Driver) in right Side of Function Block .



pbsSoftLogic has two parts :

1 - Engineering station. Running on windows Operating system

2 – Runtime Engine. Running on Embedded Linux inside RTU

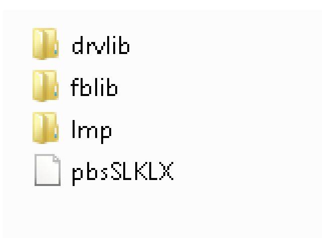
In this section we will talk about Linux Runtime engine.

You can download latest Linux runtime engine for different different controllers from http://www.pbscontrol.com page.

pbsSoftLogic Runtime Engine for Linux has following format :

- It locates at /home/pbsLX directory
- /home/pbsLX/pbsSLKLX file is main runtime module. It is an executable Linux file.
- /home/pbsLX/lmp/libpbsLMP.so logic monitoring protocol implementation for linux .
- /home/pbsLX/fblib/libCounters.so , libLogic.so , libMath.so , libProcess.so , libTimers.so linux implementation of pbsSoftlogic internal Function blocks . For each FB group there is one linux dynamic library .
- /home/pbsLX/drvlib/mmix/libpbsModbusMLx.so pbsSoftLogic Modbus Master(RTU/TCP) implementation for linux .
- /home/pbsLX/drvlib/msix/libpbsModbusSLX.so pbsSoftLogic Modbus Slave implementation for linux .

When you unzip uc7112.rar and w406.rar you can see following directories:



For transferring pbsLX directory to controller do following tasks :

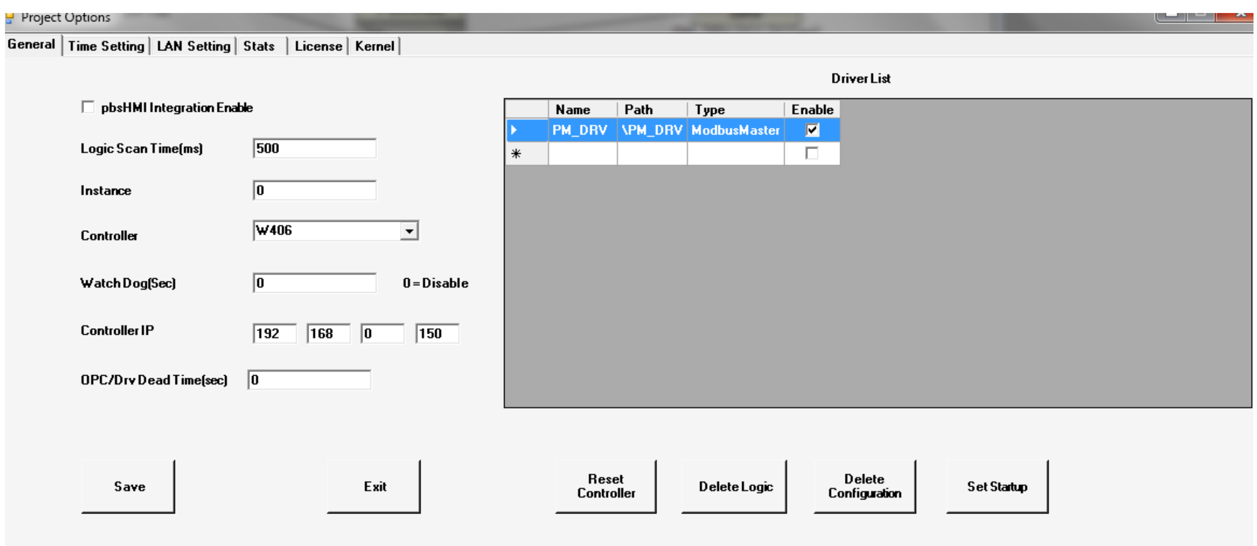
1 – Open project setting page and click on kernel Tab. To be sure that Controller IP address is correct on General Tab.

2 – Click on Browse Button and select pbsLX Directory that you want to transfer to controller. To be sure that you select correct runtime Kernel for your controller.

3 – If controller has old Runtime Kernel, first Shutdown RTU Kernel.

4 – Click on Transfer To Controller Button. It will transfer all files and directories to controller but not changing logic and configuration.

5 – If it is new controller without any kernel, in General Tab click on Set Startup Button to put all necessary modules in controller startup path.



6 – From general tab Restart Controller.

For each controller, you need to have license file for life time operation. Without License, it will work for 30 Min and you need to restart Controller.

We have following license for controller runtime:

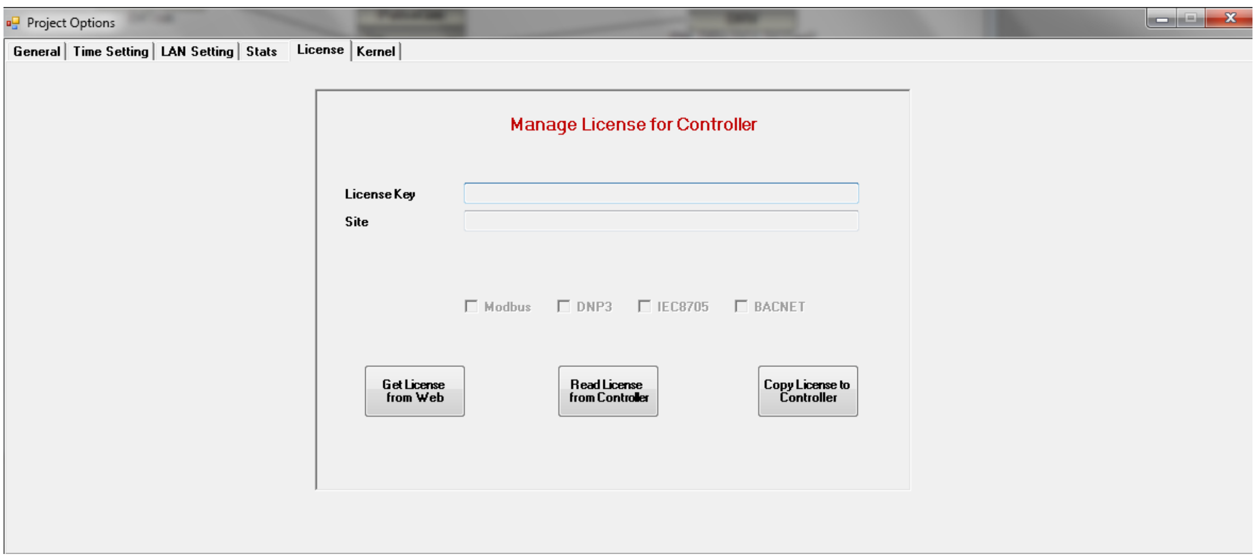
- RTU/PLC functionality and Modbus Master/Slave protocol. This is basic license for each controller.
- DNP3 Slave License.
- IEC870-5-101/104 Slave License

- BACNET License

You need to purchase each license separately from your supplier or directly through www.pbscontrol.com web site. You can purchase basic license and purchase other license for your controller. But your license key is same for each controller.

When you purchase pbsSoftLogic License, you will receive a license key. For activating license do following steps:

1 – Open project setting page and select License Tab.



2 – To be sure that your PC is connected to Internet and Controller In the same time.

3 – Copy and Paste Controller license Key to License key text Box .

4 – Write some description about your project, Project name, country,

5 – Click on get License from Web Site It will connect to pbscontrol web site and get all purchase licenses

6 – Modbus , DNP3 , IEC and BACNet check boxs will be checked based on your purchase

7 – Click on Copy License to Controller. It will move license file to controller.

8 – From General tab, restart Controller.

If you have a controller and want to check its license, click on Read License from Controller.

Working with Linux OS

pbsSoftLogic Runtime kernel is running on Linux Operating system . So you need to have basic knowledge about Linux . We will review all necessary tools and Linux commands which is used in pbsSoftLogic in this section .

pbsSoftogic Runtime kernel is developed by ANSI C and it is possible to port it to any Operating system . We already port it for QNX , Win32 and WinCE .But our default OS is embedded linux .

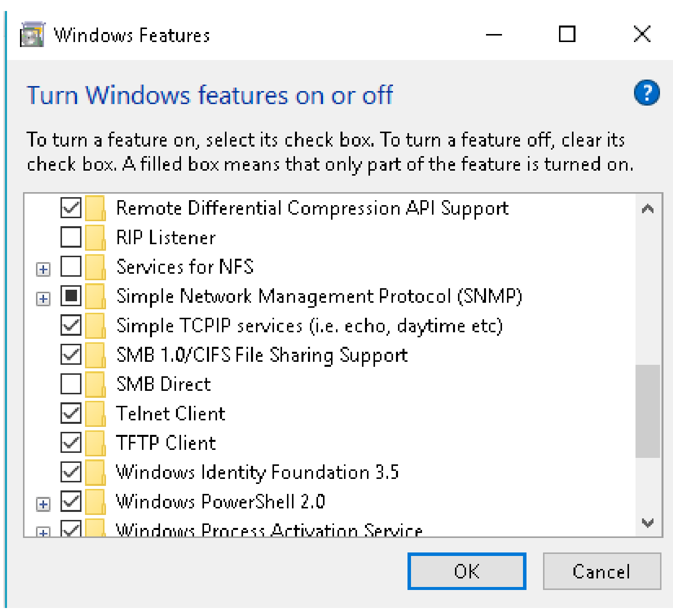
pbsSoftLogic is transferring Configuration and Logic file to RTU by FTP protocol . So you need to have FTP Server running inside RTU .

pbsSoftLogic is using Root user to transfer files , so check inside RTU Root user has access in /etc/ftpuser file . The best way to use FTP is using FileZilla Client Software . This is free utility and you can get latest version from https://filezilla-project.org/

Because Windows and Linux file format are not identical, so you need to use intelligent Editor like Notepad++ to edit Linux Configuration files in Windows and writing again files to linux . Download Notepadd++ from https://notepad-plus-plus.org/

pbsSoftLogic is using Telnet to set Project setting like RTU Date and time , Restarting RTU , … . So you need to have running Telnet Server inside RTU.

For windows engineering station you need to enable Telnet Client utility. It is located in Control Panel /program and Features /Turn Windows Features On or Off.



With telnet utility you can connect to RTU by TCP/IP network and manage RTU or change configuration remotely . Telnet is command based like old MS DOS command prompt .

In windows Engineering Station open command window and execute telnet command with RTU IP Address as following:

```
Command Prompt
C:\Users\kamjoo-T420>telnet 192.168.1.137
```

By default user name and password of pbsSoftLogic based RTUS is root, root.

```
Telnet 192.168.1.137
Debian GNU/Linux 8

BeagleBoard.org Debian Image 2016-07-10

Support/FAQ: http://elinux.org/Beagleboard:BeagleBoneBlack_Debian

default username:password is [debian:temppwd]

pbs2008_137 login: root
Password:
Last login: Mon Jan  9 13:56:55 IRST 2017 from kamjooT420 on pts/0
Linux pbs2008_137 4.4.14-bone11 #8 Wed Jul 13 21:32:55 IRDT 2016 armv7l

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
root@pbs2008_137:~#
```

You can change password of root user by passwd command in linux .

```
root@pbs2008_137:~# passwd root
Enter new UNIX password:
Retype new UNIX password:
passwd: password updated successfully
root@pbs2008_137:~#
```

You can change linux directory by cd command:

Telnet 192.168.1.137

```
root@pbs2008_137:~# cd /home/pbsLX/
root@pbs2008_137:/home/pbsLX#
```

You can see list of files by ls command:

```
root@pbs2008_137:~# cd /home/pbsLX/
root@pbs2008_137:/home/pbsLX# ls
ReadmeV2RC8.txt   drvlib   lmp        logic.cfg  startup.sh
ResetFactory      fblib    logic.c11  pbsSLKLX
root@pbs2008_137:/home/pbsLX#
```

You can see list of running process by ps aux command:

```
root@pbs2008_137:/home/pbsLX# ps aux | grep pbsSLKLX
root       495  1.9  0.6  80524  3404 ?        Sl   14:20   2:41 ./pbsSLKLX
root      3133  0.0  0.2   2076  1124 pts/0    S+   16:39   0:00 grep pbsSLKLX
root@pbs2008_137:/home/pbsLX#
```

Pbs aux will show all process that is running in RTU. But if you are looking for a specific process you can use grep as above example.

Any process in linux has an ID . in above example pbsSLKLX ID is 495 .

You can kill process by its ID with kill command as following :

```
root@pbs2008_137:/home/pbsLX# ps aux | grep pbsSLKLX
root       495  1.9  0.6  80524  3404 ?        Sl   14:20   2:41 ./pbsSLKLX
root      3133  0.0  0.2   2076  1124 pts/0    S+   16:39   0:00 grep pbsSLKLX
root@pbs2008_137:/home/pbsLX# kill 495
```

Or ou can kill process by its name with pkill command:

```
root@pbs2008_137:/home/pbsLX# ps aux | grep pbsSLKLX
root       495  1.9  0.6  80524  3404 ?        Sl   14:20   2:41 ./pbsSLKLX
root      3133  0.0  0.2   2076  1124 pts/0    S+   16:39   0:00 grep pbsSLKLX
root@pbs2008_137:/home/pbsLX# pkill pbsSLKLX
```

You can see list of running process based on CPU and Memory usage by top command:

```
top - 16:45:51 up  2:25,  1 user,  load average: 0.14, 0.11, 0.03
Tasks:  69 total,   2 running,  67 sleeping,   0 stopped,   0 zombie
%Cpu(s):  2.4 us,  1.0 sy,  0.0 ni, 96.2 id,  0.3 wa,  0.0 hi,  0.0 si,  0.0 st
KiB Mem:    506736 total,    90644 used,   416092 free,    12372 buffers
KiB Swap:        0 total,        0 used,        0 free.    43692 cached Mem

  PID USER      PR  NI    VIRT    RES    SHR S %CPU %MEM     TIME+ COMMAND
  481 root      20   0   22344   8544   5168 R  3.6  1.7   5:05.01 OpenOpcUaC+
  495 root      20   0   80524   3404   1464 S  1.7  0.7   2:47.63 pbsSLKLX
 3236 root      20   0    2988   1632   1296 R  0.3  0.3   0:00.04 top
    1 root      20   0    4456   3156   2128 S  0.0  0.6   0:06.79 systemd
    2 root      20   0       0      0      0 S  0.0  0.0   0:00.00 kthreadd
    3 root      20   0       0      0      0 S  0.0  0.0   0:04.74 ksoftirqd/0
    5 root       0 -20       0      0      0 S  0.0  0.0   0:00.00 kworker/0:+
    7 root      rt   0       0      0      0 S  0.0  0.0   0:00.04 watchdog/0
    8 root      20   0       0      0      0 S  0.0  0.0   0:00.02 kdevtmpfs
   10 root       0 -20       0      0      0 S  0.0  0.0   0:00.00 netns
   11 root      20   0       0      0      0 S  0.0  0.0   0:00.00 kswork
   12 root       0 -20       0      0      0 S  0.0  0.0   0:00.00 perf
   13 root      20   0       0      0      0 S  0.0  0.0   0:00.00 khungtaskd
   14 root       0 -20       0      0      0 S  0.0  0.0   0:00.00 writeback
   15 root      25   5       0      0      0 S  0.0  0.0   0:00.00 ksmd
   16 root       0 -20       0      0      0 S  0.0  0.0   0:00.00 crypto
   17 root       0 -20       0      0      0 S  0.0  0.0   0:00.00 kintegrityd
   18 root       0 -20       0      0      0 S  0.0  0.0   0:00.00 bioset
   19 root       0 -20       0      0      0 S  0.0  0.0   0:00.00 kblockd
   20 root       0 -20       0      0      0 S  0.0  0.0   0:00.00 ata_sff
   21 root       0 -20       0      0      0 S  0.0  0.0   0:00.00 devfreq_wq
   22 root       0 -20       0      0      0 S  0.0  0.0   0:00.00 rpciod
   23 root      20   0       0      0      0 S  0.0  0.0   0:00.00 kswapd0
   24 root      20   0       0      0      0 S  0.0  0.0   0:00.00 fsnotify_m+
   25 root       0 -20       0      0      0 S  0.0  0.0   0:00.00 nfsiod
   26 root       0 -20       0      0      0 S  0.0  0.0   0:00.00 xfsalloc
   27 root       0 -20       0      0      0 S  0.0  0.0   0:00.00 xfs_mru_ca+
   49 root       0 -20       0      0      0 S  0.0  0.0   0:00.00 kthrotld
   50 root      20   0       0      0      0 S  0.0  0.0   0:00.00 kapmd
   53 root     -51   0       0      0      0 S  0.0  0.0   0:00.00 irq/30-480+
```

You should stop top command by presseing ctrl+c keys.

If you want to run a program from current directory you should use ./ to run application .

Telnet 192.168.1.137

```
root@pbs2008_137:~# cd /home/pbsLX/
root@pbs2008_137:/home/pbsLX# ./pbsSLKLX
```

If you use & after program name , application will run in background and you have still Telnet command control .

```
root@pbs2008_137:~# cd /home/pbsLX/
root@pbs2008_137:/home/pbsLX# ./pbsSLKLX &
```

For deleting files you can use rm command:

```
root@pbs2008_137:~# cd /home/pbsLX/
root@pbs2008_137:/home/pbsLX# rm logic.c11
root@pbs2008_137:/home/pbsLX# rm logic.cfg
root@pbs2008_137:/home/pbsLX#
```

In above example pbsSoftLogic , Logic and hardware configuration files are removed .

For making a new directory you can use mkdir command.

```
root@pbs2008_137:/home/pbsLX# mkdir test
root@pbs2008_137:/home/pbsLX#
```

When you copy an exactable file to RTU and wants to run it , you need to make it as exactable by chmod command :

Telnet 192.168.1.137

```
root@pbs2008_137:/home/pbsLX# chmod +x pbsSLKLX
```

If you want to see RTU hardware information you can use /proc directory files:

```
root@pbs2008_137:/home/pbsLX# cat /proc/cpuinfo
processor       : 0
model name      : ARMv7 Processor rev 2 (v7l)
BogoMIPS        : 996.14
Features        : half thumb fastmult vfp edsp thumbee neon vfpv3 tls vfpd32
CPU implementer : 0x41
CPU architecture: 7
CPU variant     : 0x3
CPU part        : 0xc08
CPU revision    : 2

Hardware        : Generic AM33XX (Flattened Device Tree)
Revision        : 0000
Serial          : 0000000000000000
root@pbs2008_137:/home/pbsLX#
```

date command will show or set current Date Time of RTU :

Telnet 192.168.1.137

```
root@pbs2008_137:/home/pbsLX# date
Mon Jan  9 17:13:30 IRST 2017
root@pbs2008_137:/home/pbsLX#
```

Uptime shows for how long RTU is not restarted.

```
root@pbs2008_137:/home/pbsLX# uptime
 17:14:45 up 25 min,  1 user,  load average: 0.16, 0.06, 0.01
root@pbs2008_137:/home/pbsLX#
```

You can see flash memory and mount derives status by df –h command

```
root@pbs2008_137:/home/pbsLX# df -h
Filesystem       Size  Used Avail Use% Mounted on
udev              10M     0   10M   0% /dev
tmpfs             99M  4.3M   95M   5% /run
/dev/mmcblk0p1   3.6G  1.1G  2.3G  32% /
tmpfs            248M  4.0K  248M   1% /dev/shm
tmpfs            5.0M     0  5.0M   0% /run/lock
tmpfs            248M     0  248M   0% /sys/fs/cgroup
tmpfs             32M   20K   32M   1% /mnt/ramdisk
root@pbs2008_137:/home/pbsLX#
```

You can see memory status by cat /proc/meminfo command

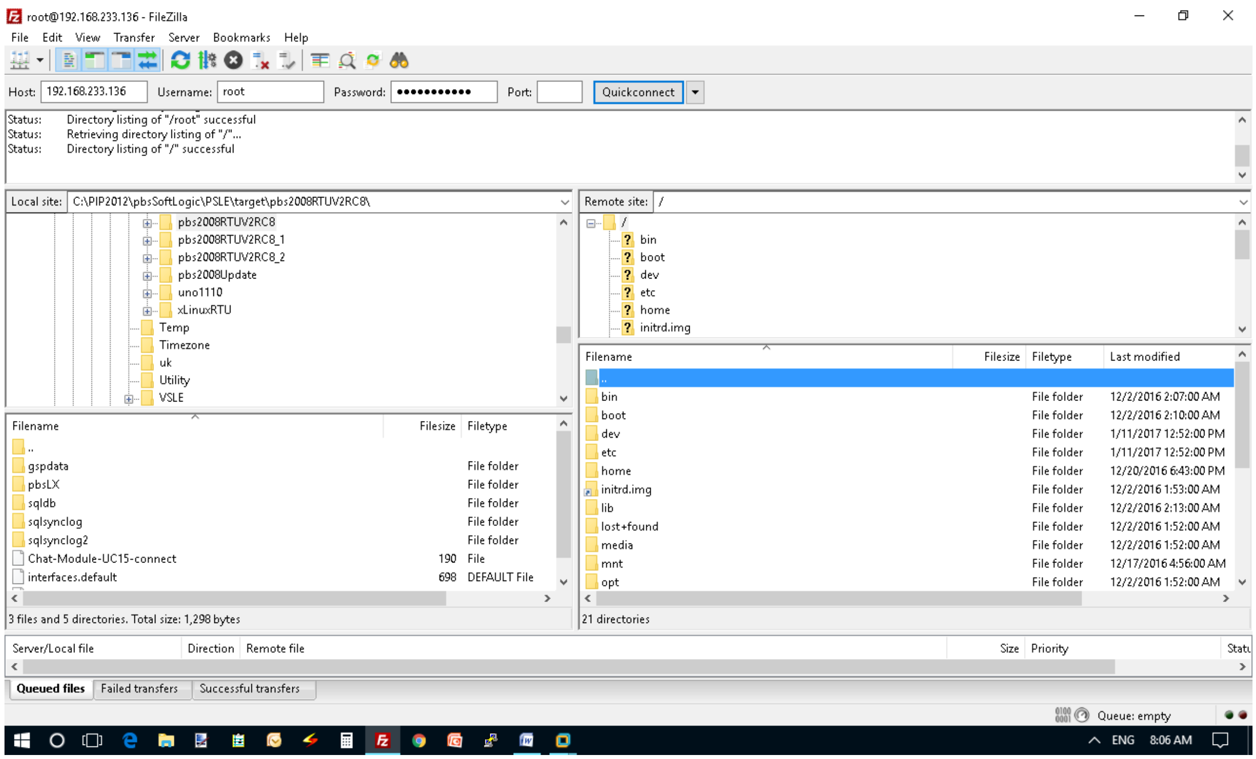
```
root@pbs2008_137:/home/pbsLX# cat /proc/meminfo
MemTotal:         506736 kB
MemFree:          432860 kB
MemAvailable:     464880 kB
Buffers:            7980 kB
Cached:            31712 kB
SwapCached:            0 kB
Active:            35992 kB
Inactive:          19456 kB
Active(anon):      15876 kB
Inactive(anon):     4284 kB
Active(file):      20116 kB
Inactive(file):    15172 kB
Unevictable:           0 kB
Mlocked:               0 kB
HighTotal:             0 kB
HighFree:              0 kB
LowTotal:         506736 kB
LowFree:          432860 kB
SwapTotal:             0 kB
SwapFree:              0 kB
Dirty:               104 kB
Writeback:             0 kB
AnonPages:         15768 kB
Mapped:            15580 kB
Shmem:              4408 kB
Slab:              13612 kB
SReclaimable:       7844 kB
SUnreclaim:         5768 kB
KernelStack:         720 kB
```

Working with FileZilla

You can use FileZilla client utility to explore and edit RTU Files and directories.

Download filezilla from https://filezilla-project.org/

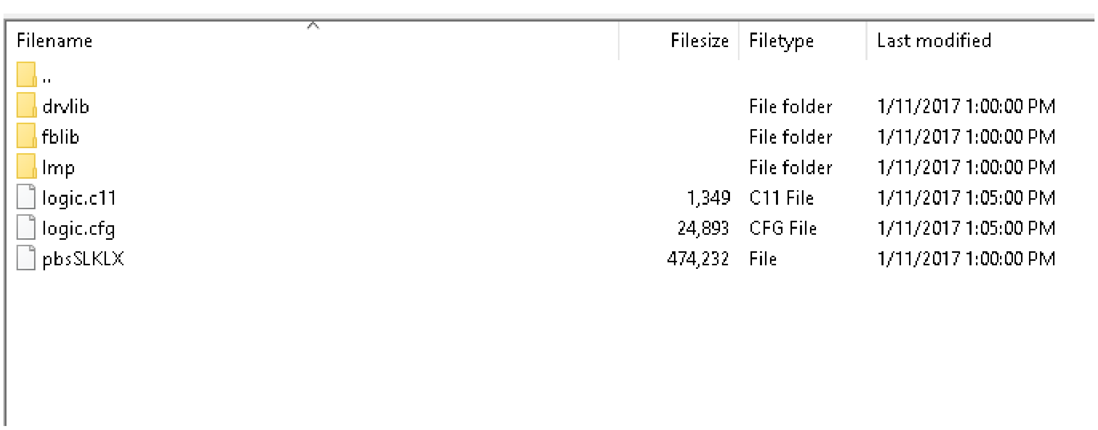
Run filezilla client you will see following page :



Type RTU IP at host field. Type root and root password in user name and password fields .

All RTU directories are showing at right panels and your PC directories at left s panels.

Double click on home directory. You will go inside home directory. Double click on pbsLX . pbsLX directory is runtime kernel of pbsSoftLogic for Linux Operating system .

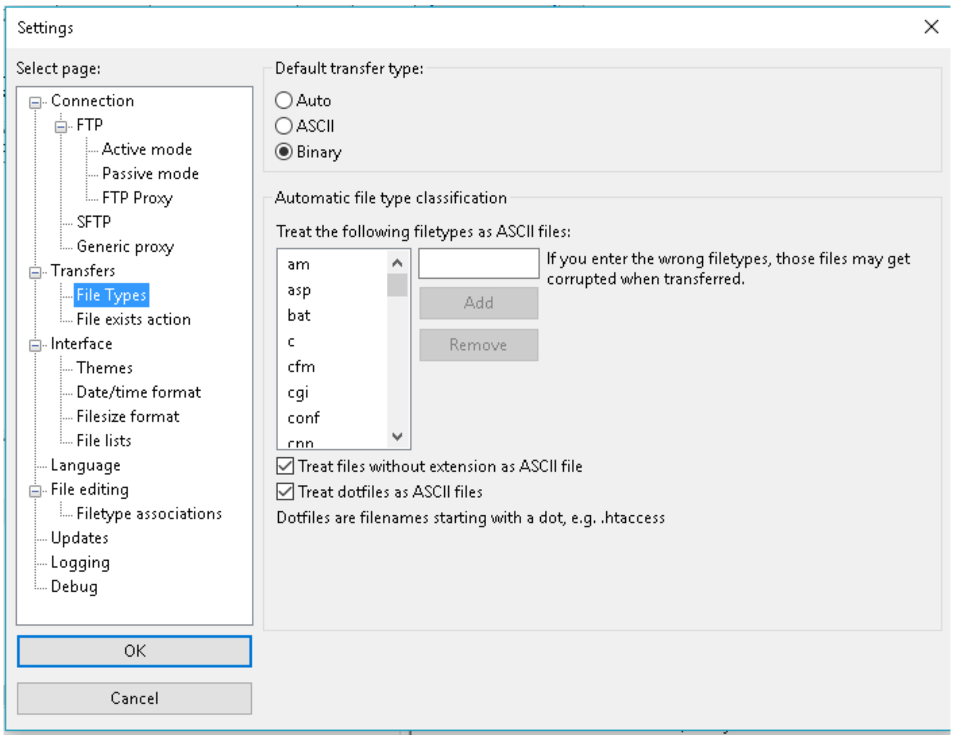


Filename	Filesize	Filetype	Last modified
..			
drvlib		File folder	1/11/2017 1:00:00 PM
fblib		File folder	1/11/2017 1:00:00 PM
lmp		File folder	1/11/2017 1:00:00 PM
logic.c11	1,349	C11 File	1/11/2017 1:05:00 PM
logic.cfg	24,893	CFG File	1/11/2017 1:05:00 PM
pbsSLKLX	474,232	File	1/11/2017 1:00:00 PM

If you install debian X86 Linux on your pc over VMWare or Virtual Box, then you can easily use pbsSoftLogic Debian X86 Runtime and test all functionalities of pbsSoftLogic on your PC.

pbsSoftLogic Kernel for UNO1252G is Debian Runtime for X86 CPU .

Note : for transferring files between Windows and Linux Systems , always set Transfer File Type to Binary. you can find this option in Edit Menu , Setting menu and Transfers Segment .



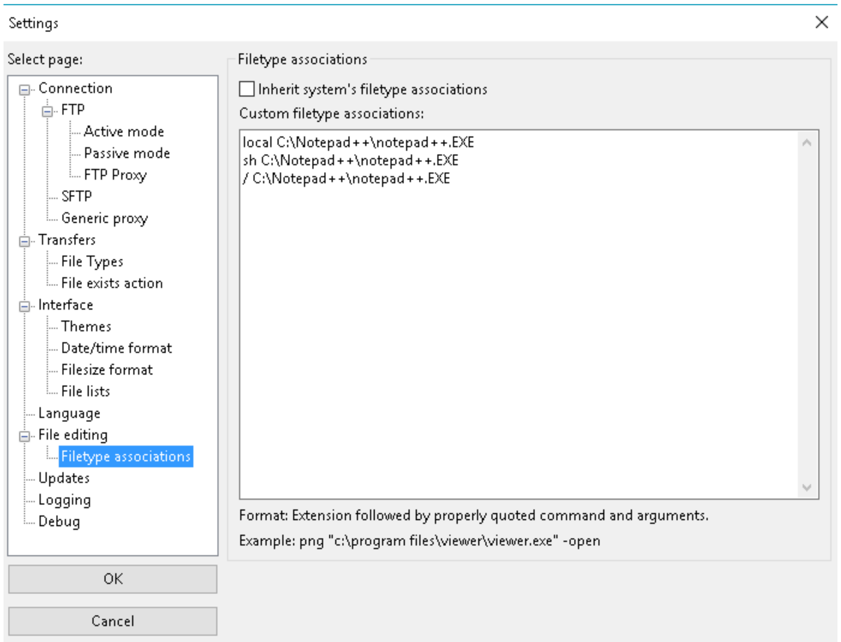
By default it is set to "Auto" that is damaging Linux files at transfer time from Windows to RTU.

For editing RTU configuration files in windows you need to use NotePad++ Editor to not damage Text file format when transfer to windows System .

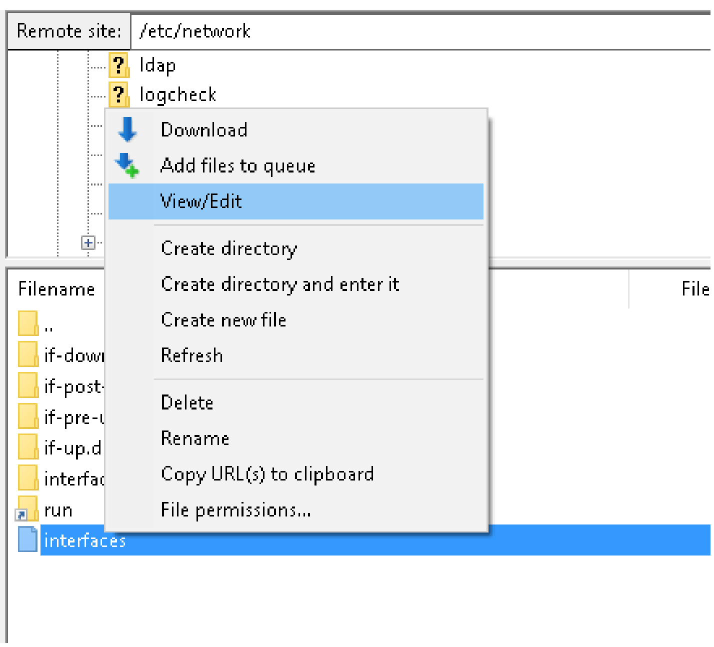
Install NotePad++ utility from https://notepad-plus-plus.org/

At first time that you View/Edit any Linux Configuration file , Filezilla will ask you for Custom Editor .

In this Stage set Nodepad++ as default editor in Filezilla . This will change File Editing Option in Setting page as following :



For changing Network Interfaces in RTU , View/Edit /etc/network/interfaces file .



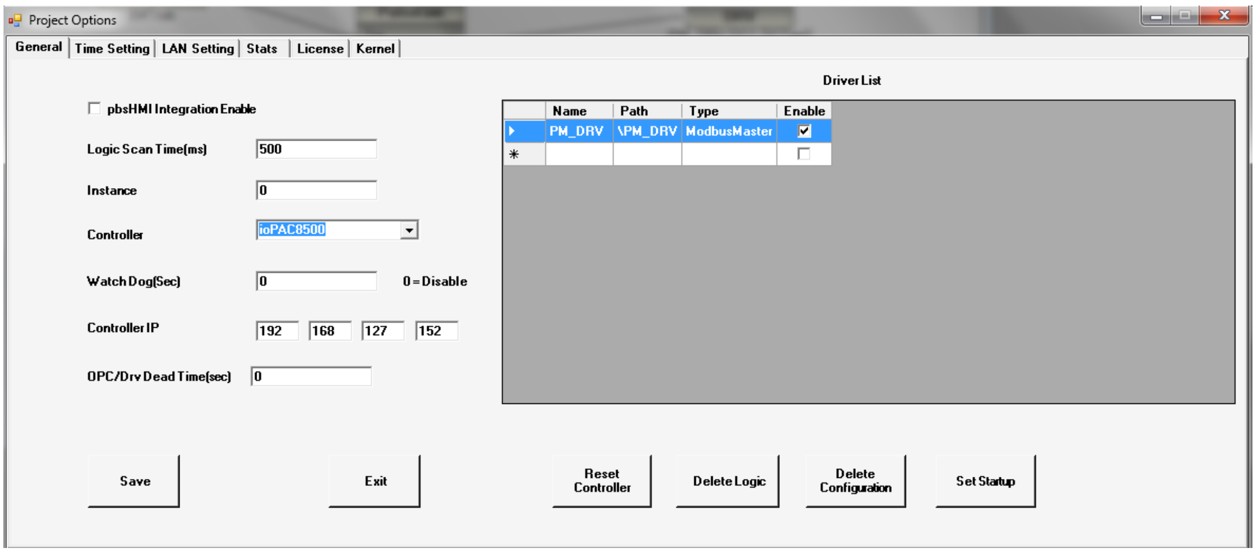
For transferring files from RTU to Windows, Select File, Right click on name of File or Directory and run “Download” command.

You can delete or Rename files inside RTU by selecting file, right click on name of file and select Delete or Rename Commands.

12 – Project Settings facilities

There are many facilities in setting page in pbsSoftLogic Editor.

Open Setting Page you can see following tabs:

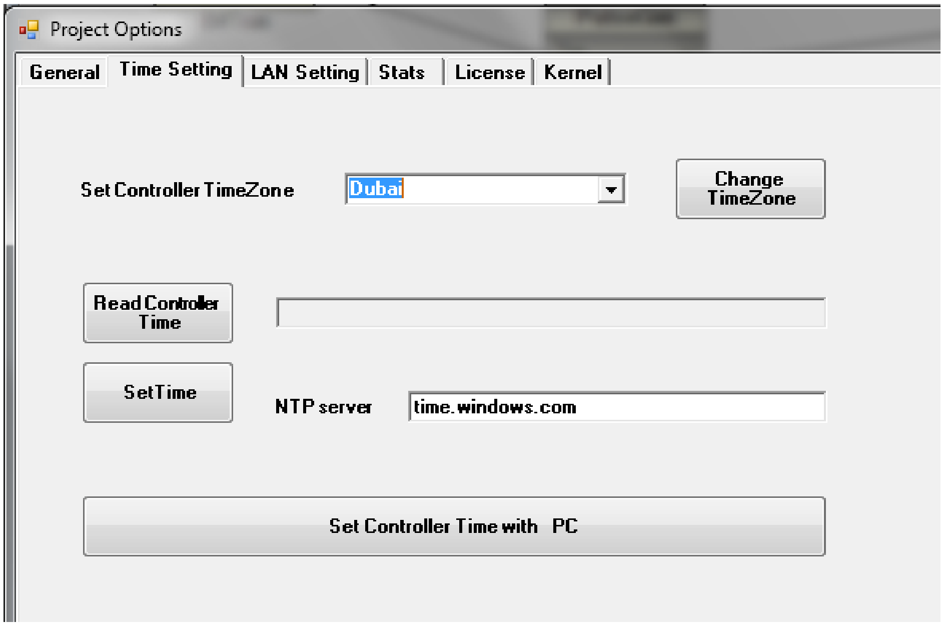


- General
- Time Setting
- LAN Setting
- Stats
- License
- Kernel

General Tab: In This page you can set following parameters:

- Logic Scan time (Msec)
- Controller Type
- Watch Dog Value in sec , if Value is 0 , DWT is disabled
- Controller IP address
- Communication Drivers
- Restart Controller
- Delete Logic
- Delete Configuration
- Set Startup: will set all necessary modules in Startup path of controller. For a new controller before running any Commands in setting page, you need to set Startup and restart controller manually.
-

Time Setting:



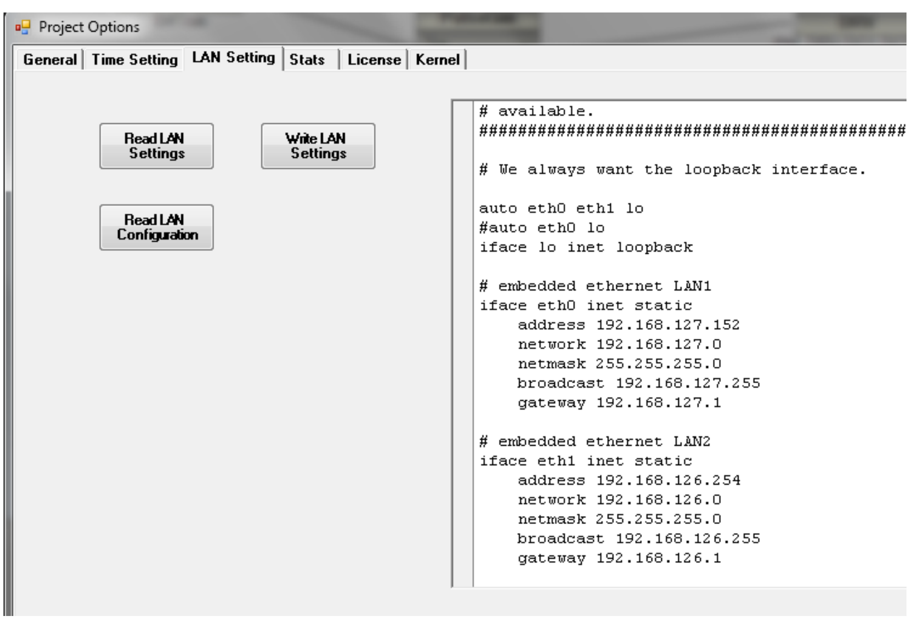
Set Controller Time Zone: Select your location from list box, and click on Change TimeZone .

Read Controller Time : Will read current Date time and time Zone of controller .

Set Time : will set Controleller time from NTP Server , it can be a computer on the network or any Time web site . But controller should connect to Internet.

Set Controller Time with PC : It will set Controller time from PC that is running pbsSoftLogic .

LAN Settings:



Read LAN Setting: It will read current LAN Setting from Controller.

Write LAN Settings: it will Write LAN settings to controller

Read LAN Configuration: it will read current ALN configuration fro controller.

For changing controller IP address:

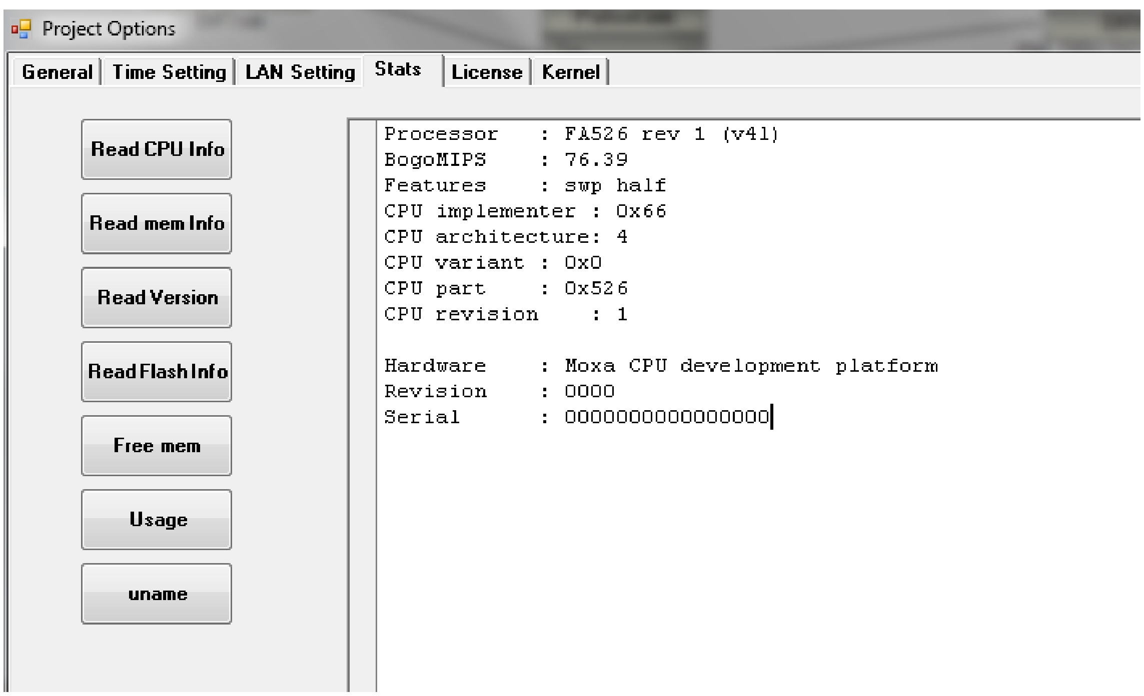
1 – Read LAN Settings

2 – Change IP address for each LAN port and other settings

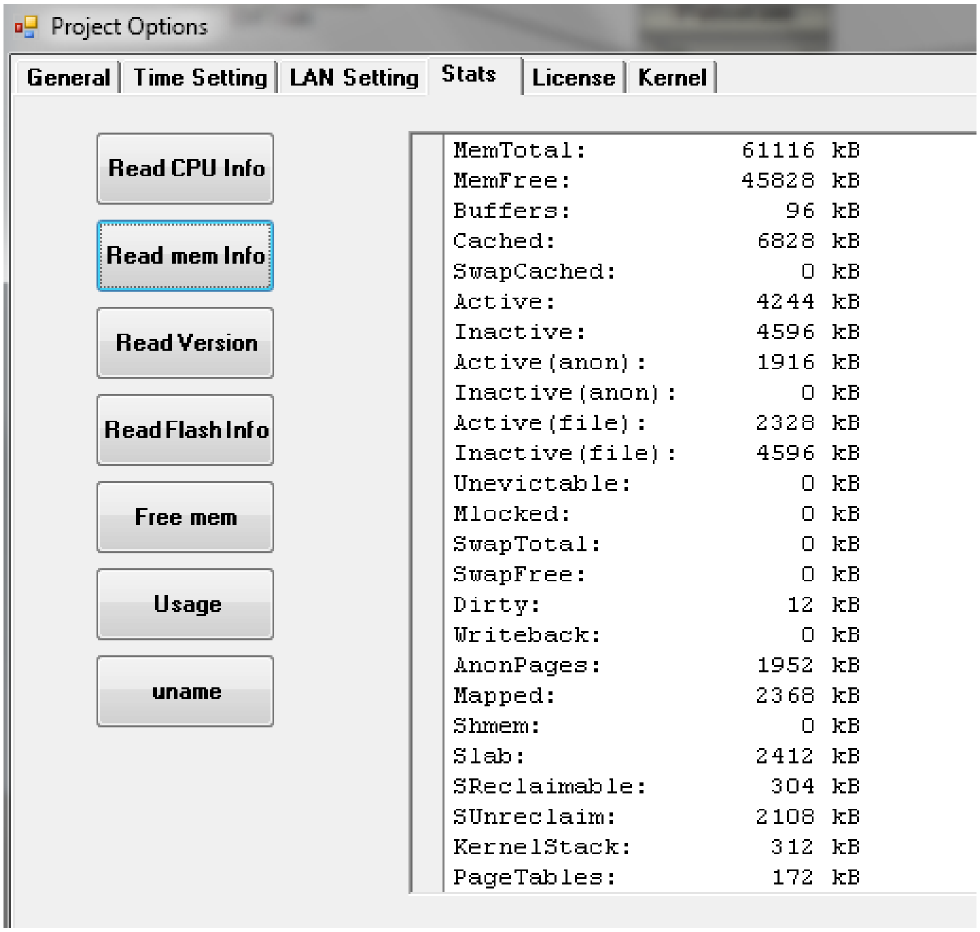
3 – Write New Settings to Controller.

Controller Stat tab:

Read CPU Information: It will Read Hardware Information from controller

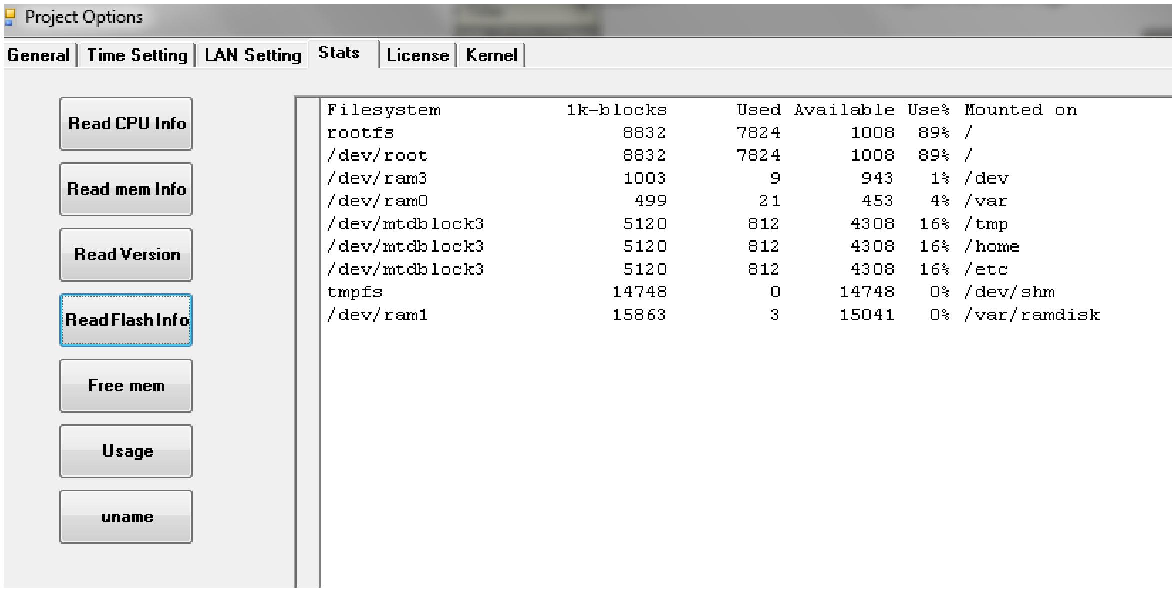


Read memory information: shows detail of memory usage of controller

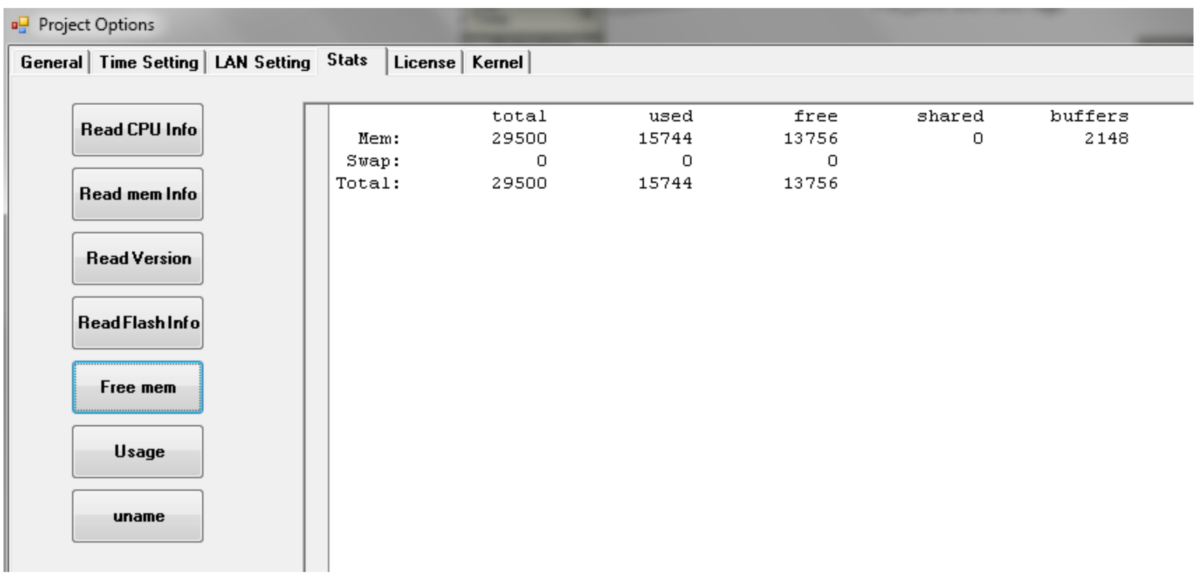


Read Version: Read Controller Linux Version, GCC compiler version

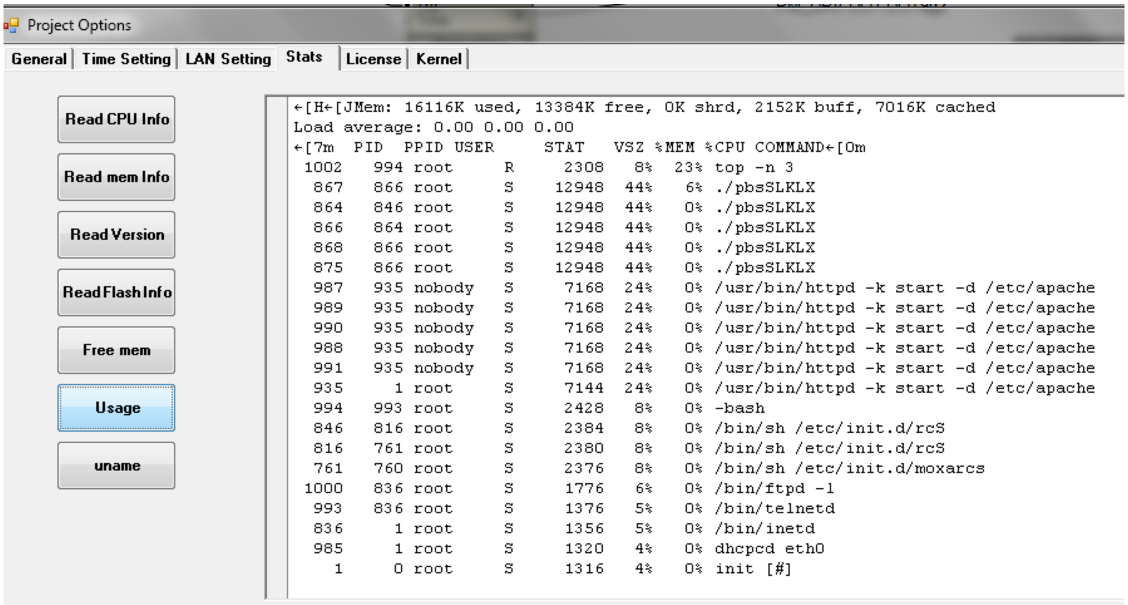
Read Flash Information:



Read Free Memory:



Usage: this is equal to top command in linux .



13 – OPC Client Driver Configuration for Win32 Target.

pbsSoftlogic Version 1.7 supports Windows 32 Target the same way as Linux and wince target .

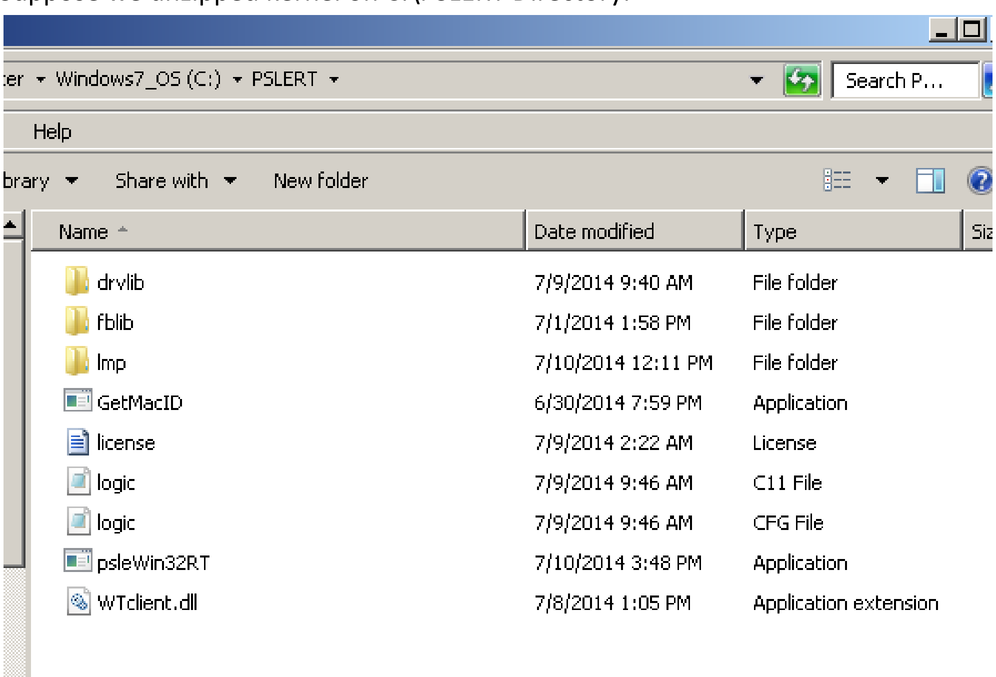
There are two windows32 runtime kernels for pbsSofLogic:

- Runtime kernel that is based on OPC standard. (VSLE.exe) we named this kernel PCWIN32 in project setting. This is pure Dot Net Kernel and is developed by C# .VSLE .exe is mostly used for Subsystem integration based on OPC technology.

- Runtime kernel that is compiled from Linux and wince kernel c source code for win32. This is high performance kernel and can be used as PLC/RTU applications on embedded Win32 controller. We named this kernel WIN32 in project setting. This part is talking about Win32 runtime and how we can use it. Win32 Kernel is just based on driver concepts and it has following drivers built in :

    - Modbus RTU/TCP master /Slave
    - DNP3 Master/Slave
    - IEC870-5-101/104 Master/Slave
    - IEC870-5-103 master
    - OPC client Driver
    - OPC server Driver
    - Open API Driver for C interfacing with runtime kernel.

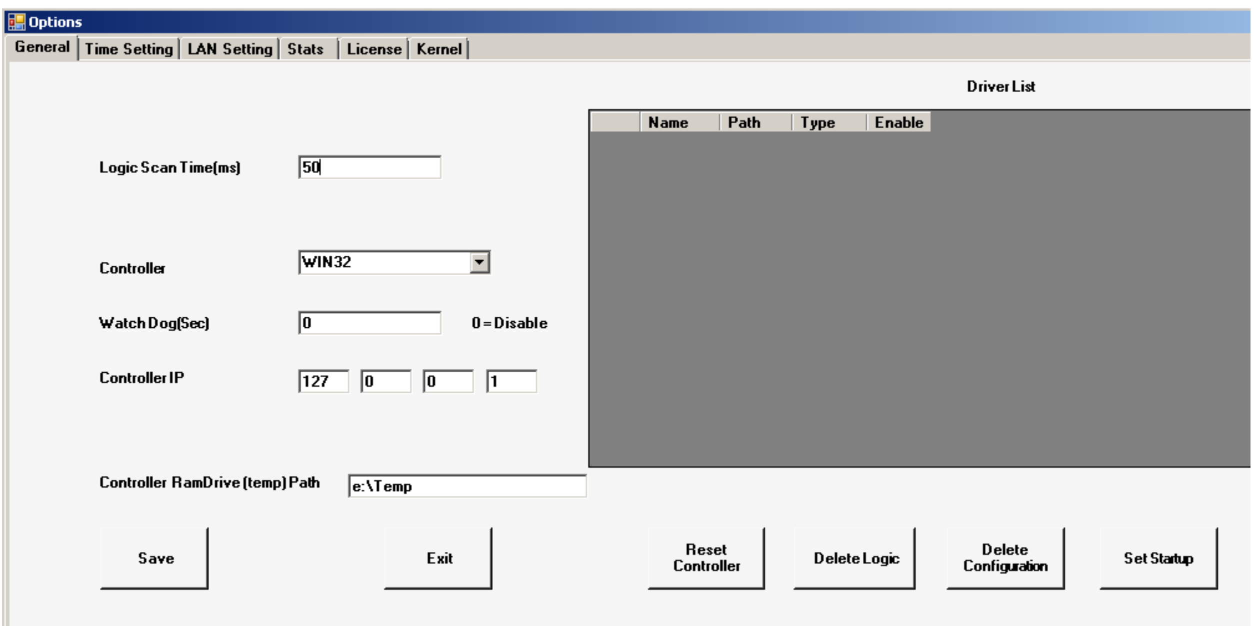
Download latest Win32 target from www.pbscontrol.com . Unzip it on any drive in your controller. Suppose we unzipped kernel on C:\PSLERT Directory.



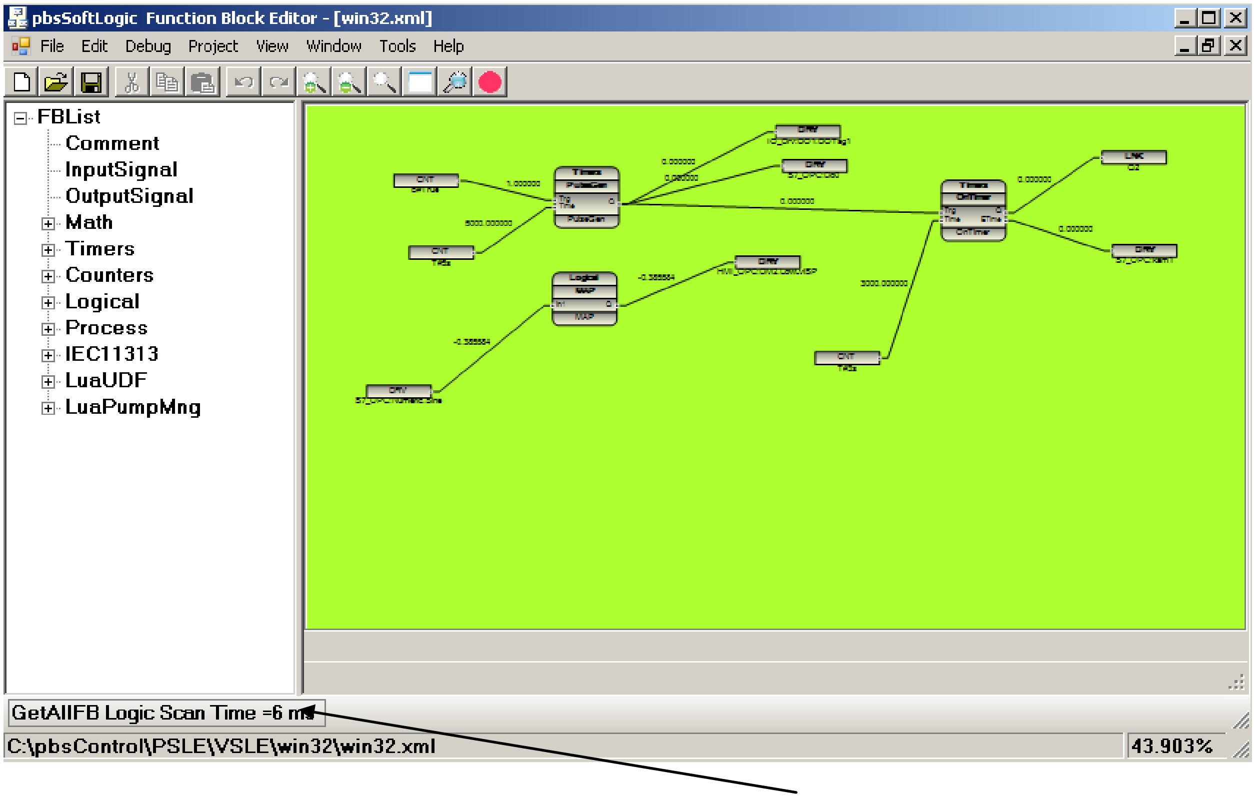
- psleWin32RT.exe is main application for kernel. It should be in Windows Auto start routine.
- Logic.c11 compiled pbsSoftLogic Logic file. Transferred by pbsSoftlogic Eng
- Logic.cfg compiled pbsSoftlogic Configuration file. Transferred by pbsSoftlogic Eng
- License.lic license file that is linked to MACID of Controller. psleWin32RT.exe will works for 30 min without License file .
- GetMacID.exe utility program for making license file. You need to run getMacID.exe and send MacID to supplier for getting permanent license file.
- Drvlib : communication driver library
- Fblib : Function block implementation library (c and Lua)
- Lmp : Logic monitoring protocol library
- WtClient.dll main dll file for OPC DA2.0 client driver.

pbsSoftlogic is using FTP for transferring logic and configuration file to Controller . So you need to install FTP server on target controller with Windows32 OS. Install FileZilla server or use internal windows FTP Server services and define "root" user with "root" password.
Set C:\PSLERT as default path of FTP server for "root" user. "root" user should has write/read access to c:\PSLERT directory.

Make a new project and set project setting as following:



Controller Type is Win32.
Logic Scan time (ms): period for reading all inputs, running logic and writing all outputs. We name this time logic scan time. When you connect and monitor logic you can see real value for logic scan time.
Logic Scan Time in settings = Real Logic Scan Time + sleep Time
Suppose you set Logic Scan time in Setting page to 50 ms, but real logic scan time is 20 ms . So kernel will sleep for 30 ms at each cycle.



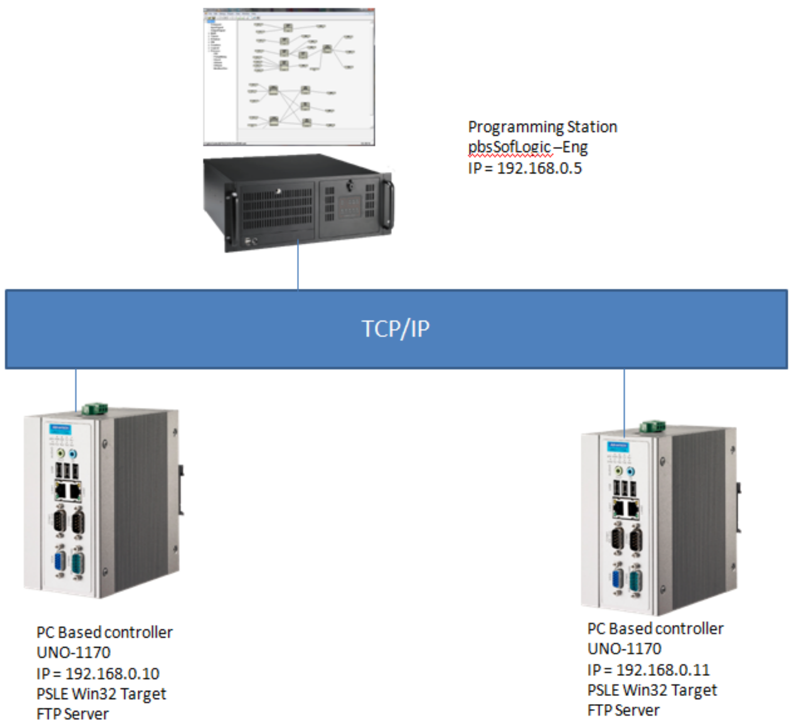
You can see real logic scan time at bottom side of logic monitoring page. In above sample, real logic scan time is 6 ms.

When you are using drivers like modbus , you need to add Modbus scan time to logic scan time to calculate real scan time of whole IO and logic .

Controller RAM Driver (Temp) Path: pbsSoftLogic runtime kernel is using files for keeping static data of Function blocks. Because at each scan runtime kernel is open, read and write static data to files, so it is too much better to use ram drive for saving static data files.

You can download very professional and free RAM Disk Driver from http://memory.dataram.com/products-and-services/software/ramdisk Web Site. We tested Data ram disk in many projects and it is 100% compatible with pbsSoftLogic .

Controller IP: you can use PC based controllers like UNO-1150 , UNO-1170 and use separate laptop for programming . Then you need to set PC Based controller IP here. When programming PC and controller PC are same, then you can use 127.0.0.1 as Controller IP.



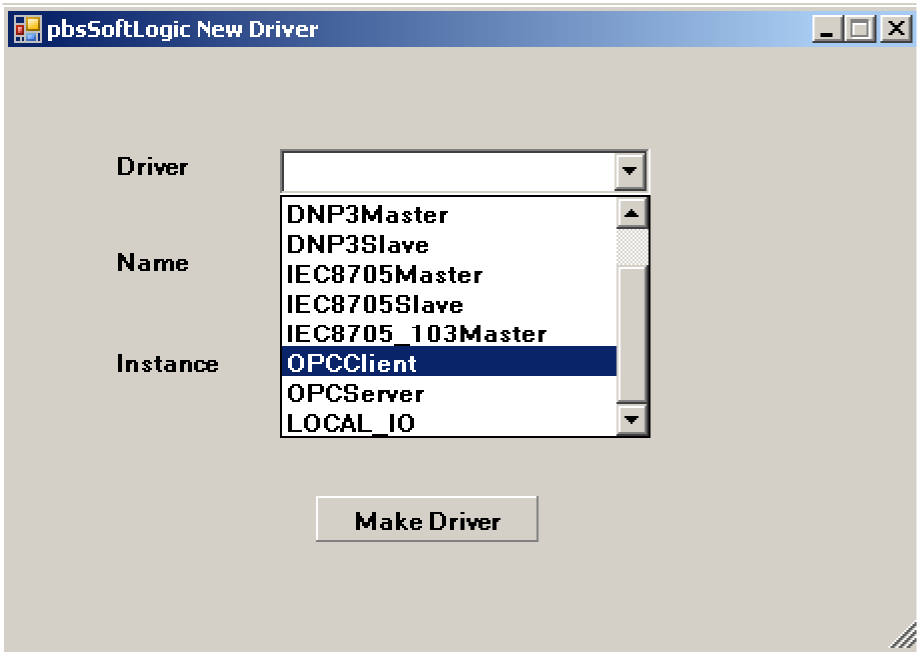
In above sample, we used two UNO-1170 as controllers and one station as programming station.

You need to make two separate project for each UNO-1170.

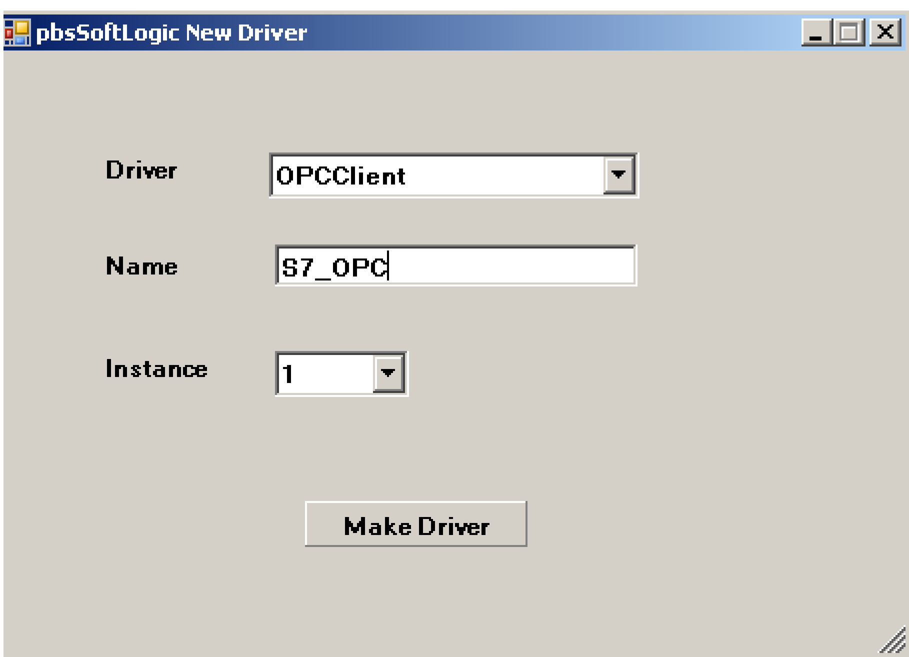
If you need to pass data between controllers, then you can define modbas-TCP master on one controller and Modbus-TCP slave on another controller. You can also use DNP3 over TCP and IEC870-5-104 for communicating between two controllers.

Defining OPC client Driver

Open project setting page and right click on Driver list, then select OPCClient Driver.



Select a unique name for driver and select driver instance. You can connect to 8 OPC server on each controller in the same time. Each OPC server connection should have unique Instace ID.

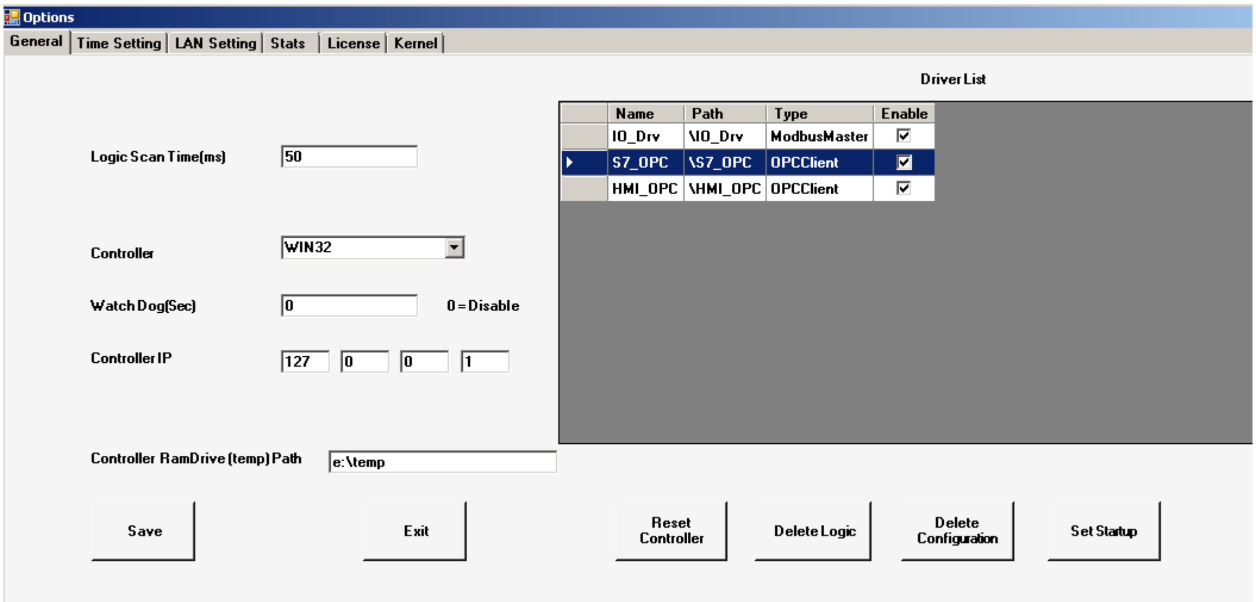


Click on “Make Driver” Button. pbsSoftLogic will make basic definition in your project .

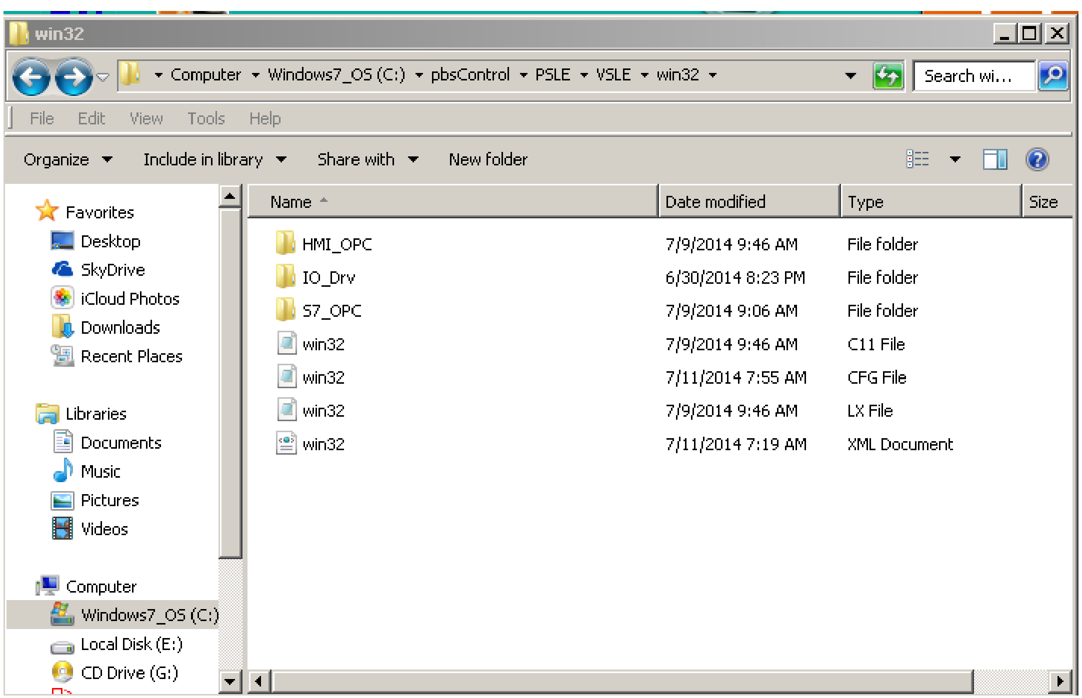
OPC client Driver : pbsSoftLogic runtime kernel will connect to other OPC servers DA2.0

OPC Server Driver : pbsSoftLogic runtime kernel will act as OPC Server and other client can connect to it.

In this part, we will talk about OPC Client Driver.

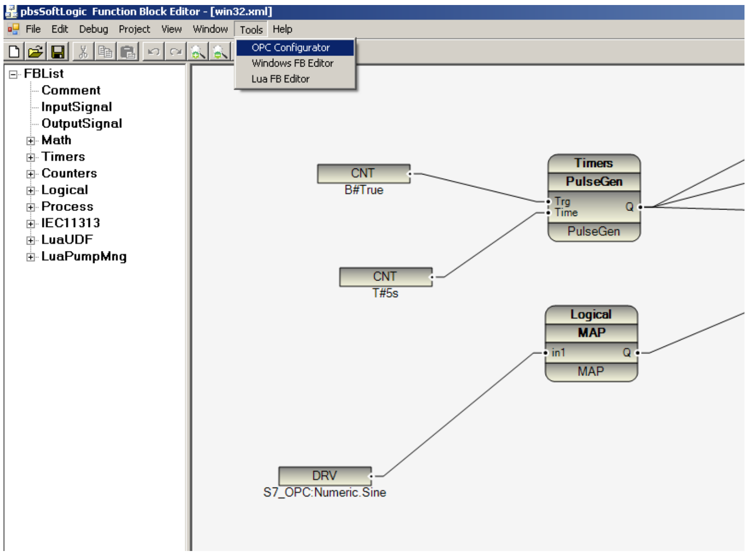


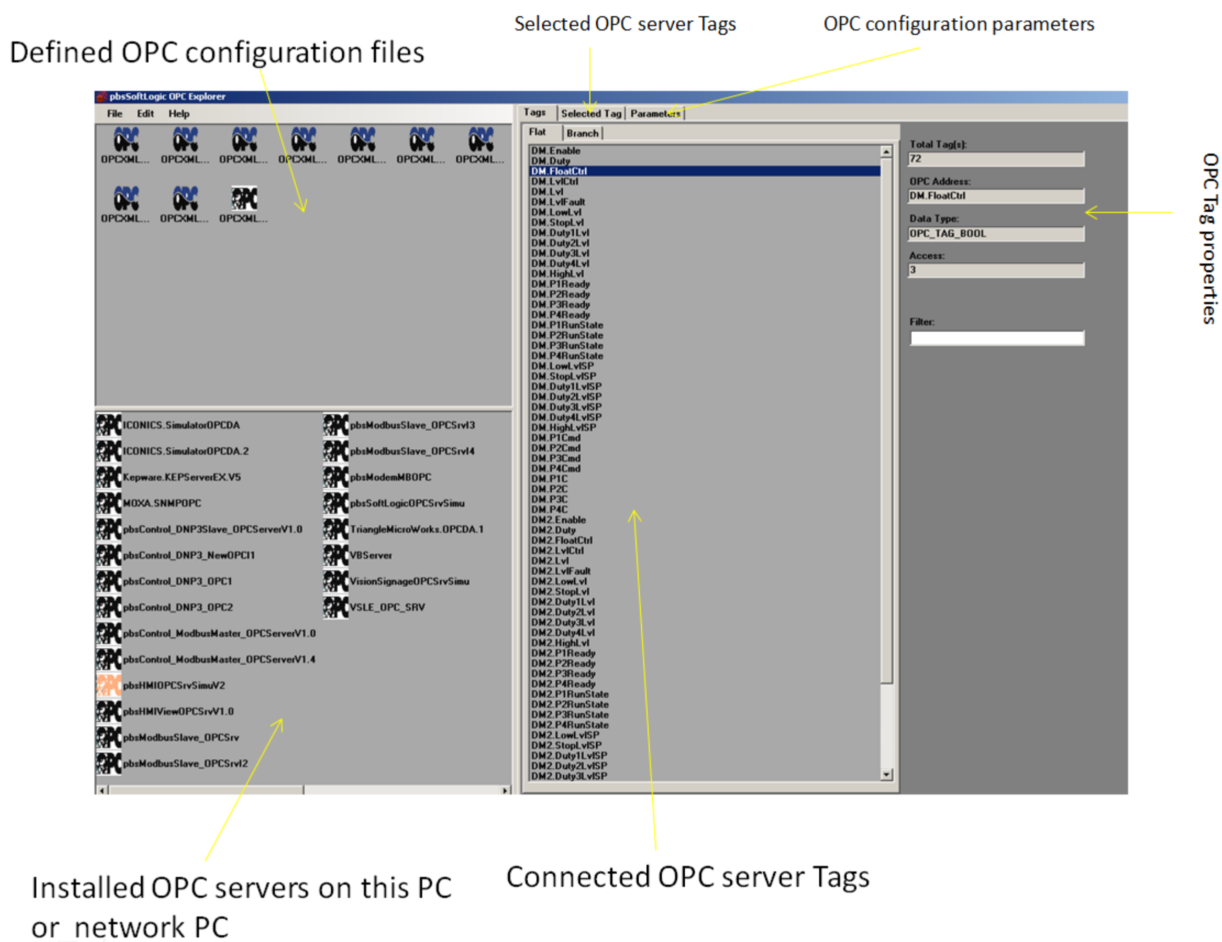
pbsSoftLogic will make a new folder in project directory with same driver name .



Inside S7_OPC directory , you can see OPCTags.xml file . we will keep all parameters and tags inside OPCTags.xml file .

For making OPCTags.xml you should use pbsSoftlogic OPC configurator utility at Tools menu .

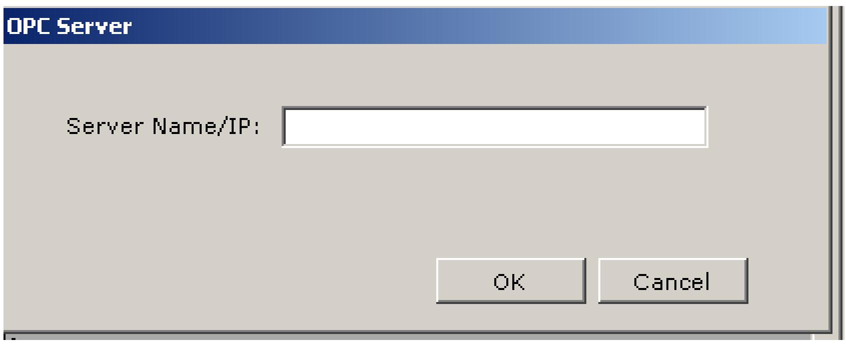




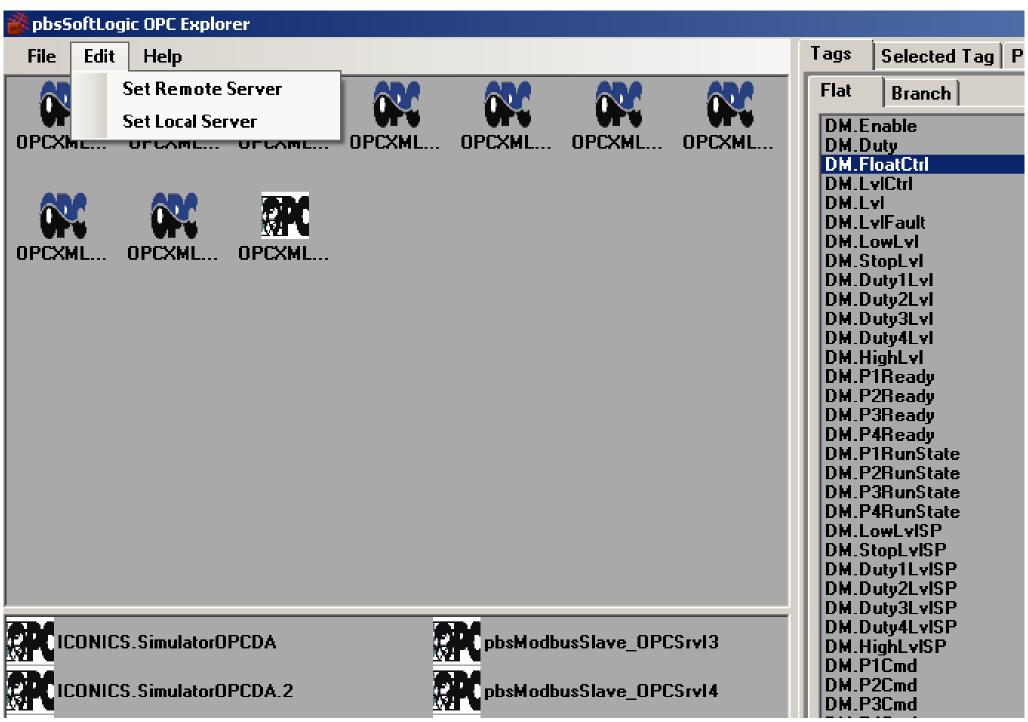
Defined OPC configuration files: At Top left panel you can see all defined OPC configuration files. These files are located at \PSLE\OPC folder.

Installed OPC Servers: At Bottom left panel you can see all installed OPC servers on this machine or remote PC. For browsing OPC servers on remote machine you need to do all setting for OPC on network for both PC . OPC network operation is dependent too much on Operating systems and it is out of scope for this document.

For connecting to remote PC , at Edit menu select "Set remote Server"   then type Server Name of IP address for getting all installed OPC servers on that Machine .

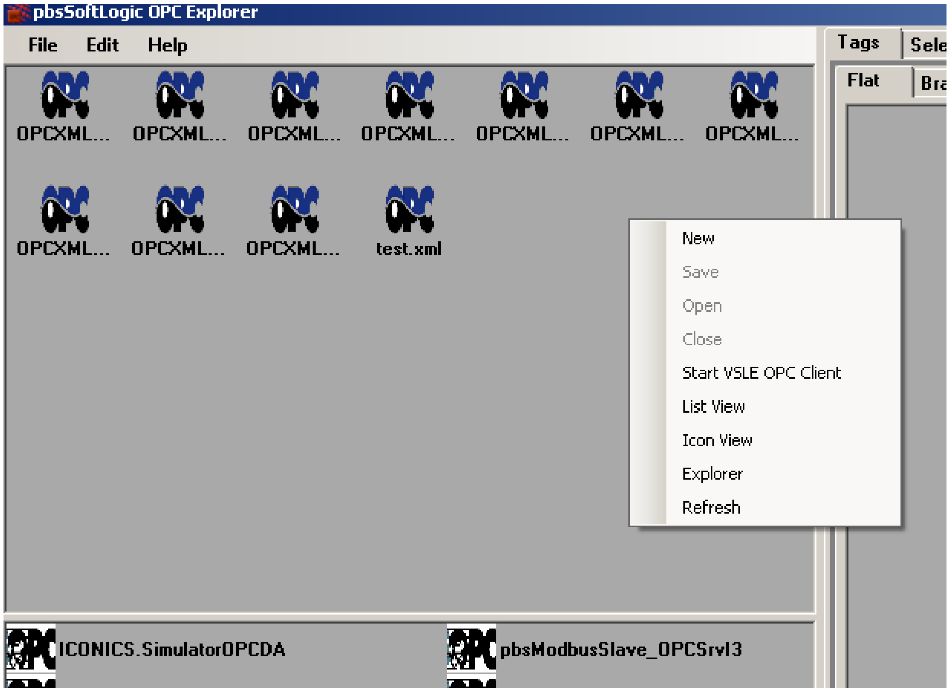


For changing to local Machine , from Edit menu select "Set Local Server".



For defining new OPC Configuration file , right click on "Defined OPC Configuration" panel .

And select "new" menu.

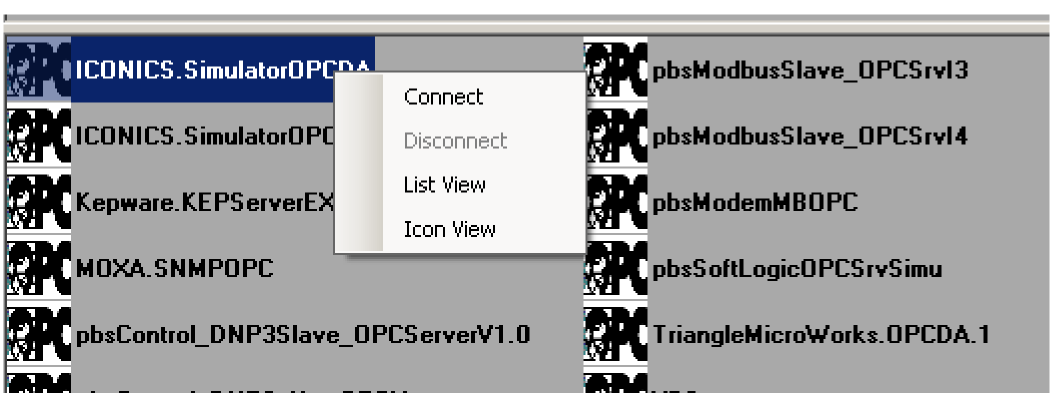


OPC explorer will look at \psle\OPC directory and find all files with OPCXMLn.xml name format and will make a new file with OPCXML{n+1}.xml name when n is max number in the OPC directory .

You can rename OPC configuration file by running Explorer menu and rename file by windows utilities.

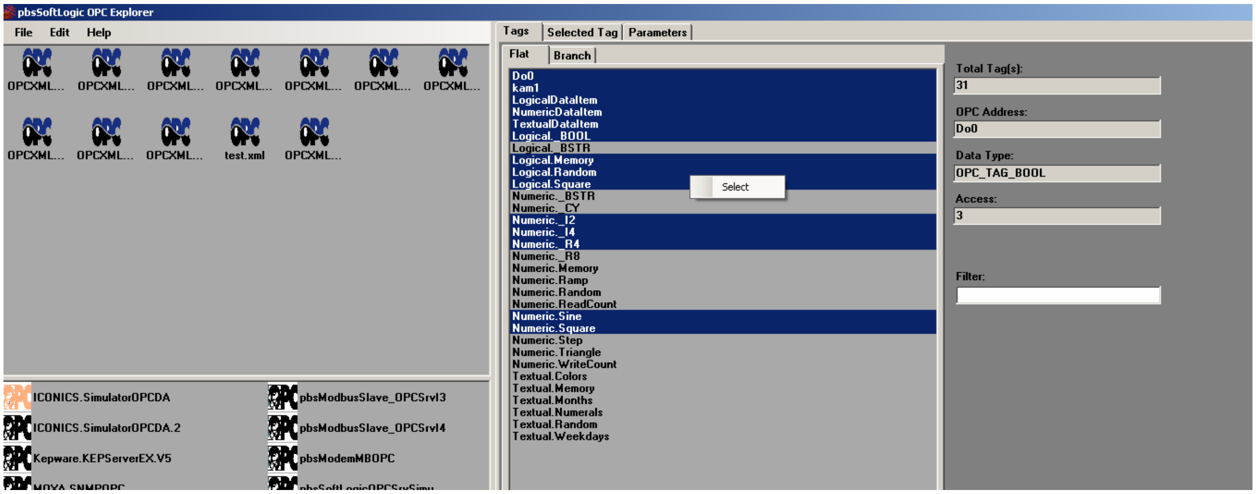
By running refresh Menu, Defined OPC configuration file panel will be refreshed with new names.

After you make a new OPC configuration file, select OPC server at Installed OPC server panel and connect to OPC server by right click menu.



From OPC server tags Panel, select all tags that you want to add in configuration. You can use Filter at right side to find OPC tags. You can press and hold Ctrl Key and select multiple items by left click.

Right click on selected Tags and run “Select” Menu.

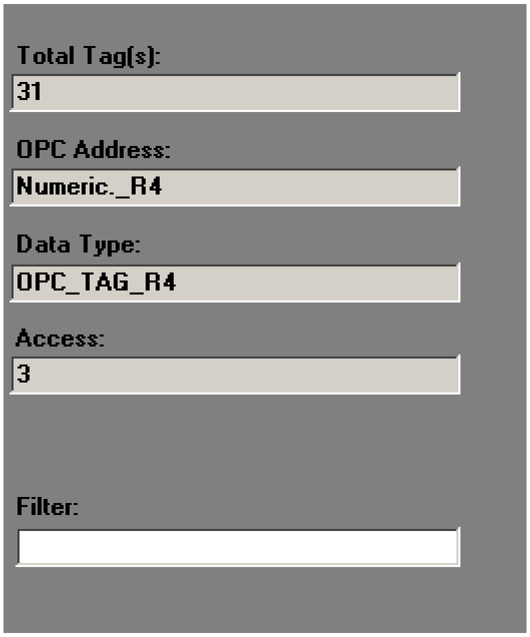


String and date data types are not supported in pbsSoftLogic for OPC client Driver.

Following Data Types are supported:

VT_I2	2 byte signed int
VT_I4	4 byte signed int
VT_R4	4 byte real
VT_R8	8 byte real
VT_BOOL	True=1, False=0
VT_I1	signed char
VT_UI1	unsigned char
VT_UI2	unsigned short
VT_UI4	unsigned long
VT_I8	signed 64-bit int
VT_UI8	unsigned 64-bit int
VT_INT	signed machine int
VT_UINT	unsigned machine int

At right Panel you can see OPC tag properties:



Tag Access :

OPC server tag has Read Access by client = 1

OPC server tag has write Access by client = 2

OPC server tag has Read/write Access by client = 3

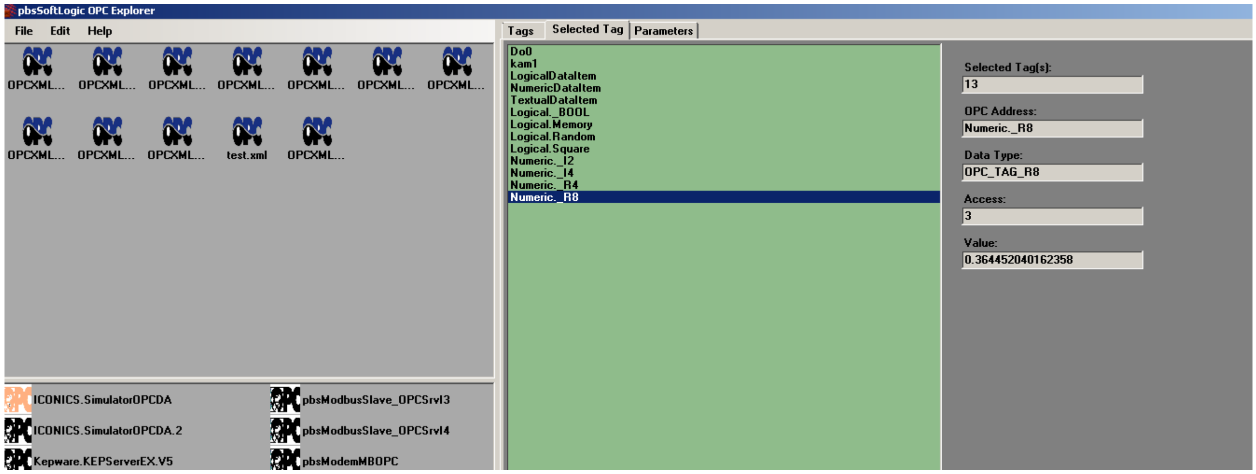
VT_BOOL has different definition in OPC:

```
VT_BOOL                 True=-1, False=0
```

But in pbsSoftLogic Runtime kernel, it is mapped as following:

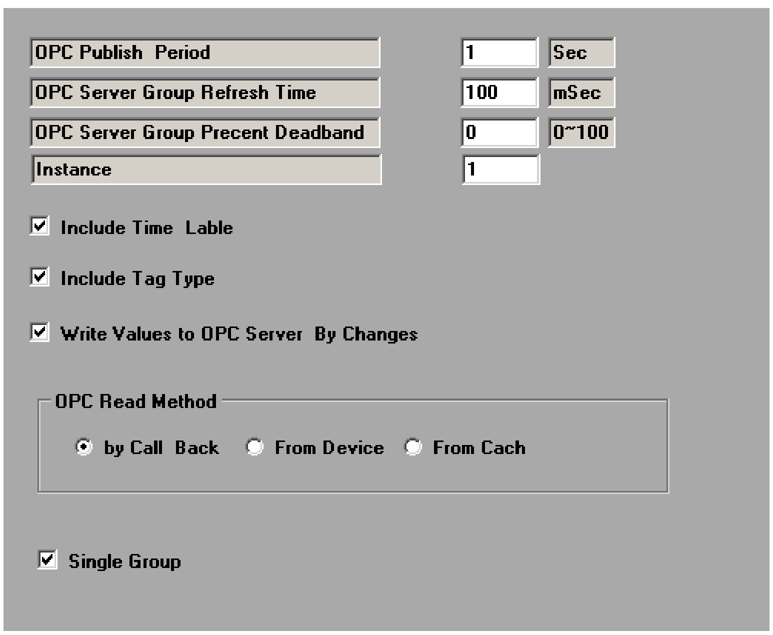
```
VT_BOOL                 True=1, False=0
```

After selecting OPC tags, click on “Selected Tags” Tab. you can see list of selected tags and at right side Tag properties with Tag Value.



When you click on each tag, Tag properties will be update at right panel.

Click on “Parameters” tab. you can see OPC connection parameter page.



OPC driver uses following parameters:

- OPC Server Group refresh Time
- OPC Server Group percent Dead band
- Instance

Other parameters are for PCWIN32 target and not used in Win32 Target.

OPC Server Group percent Dead band definition from OPC standard:

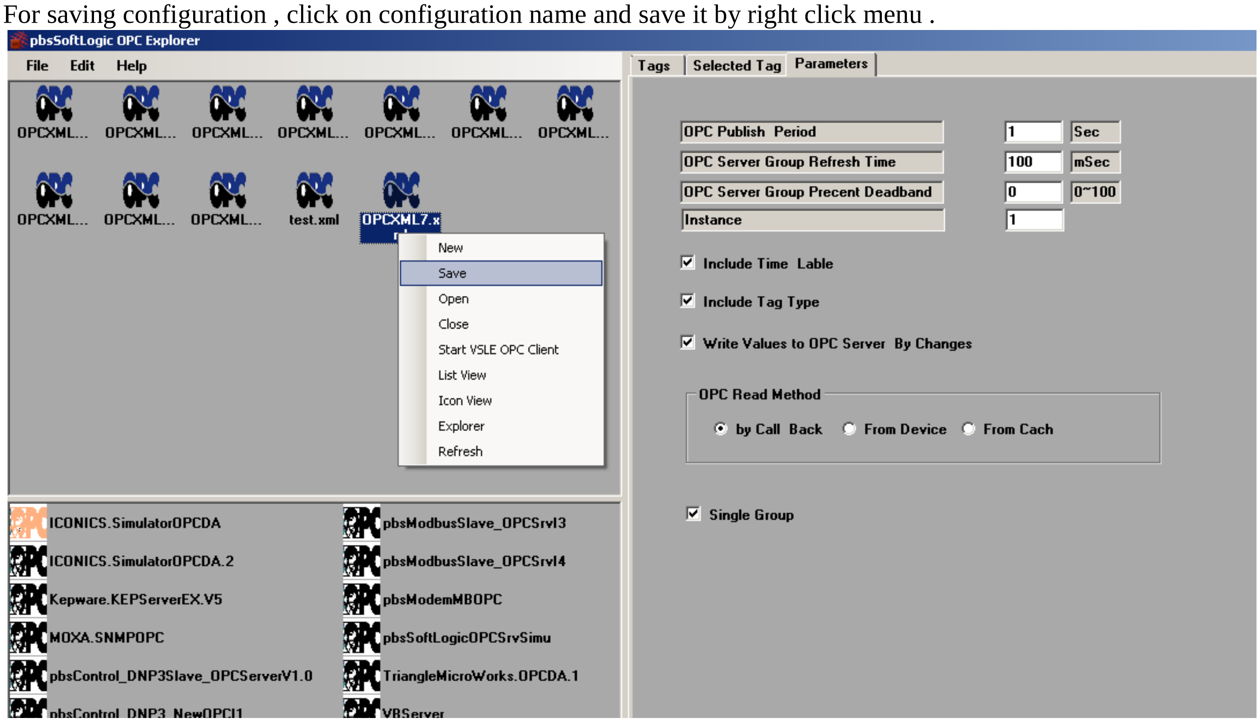
The percent change in an item value that will cause a subscription callback for that value to a client. This parameter only applies to items in the group that have Analog signals.

OPC Server Group refresh Time definition from OPC standard:

The fastest rate at which data changes may be sent to client for items in this group.

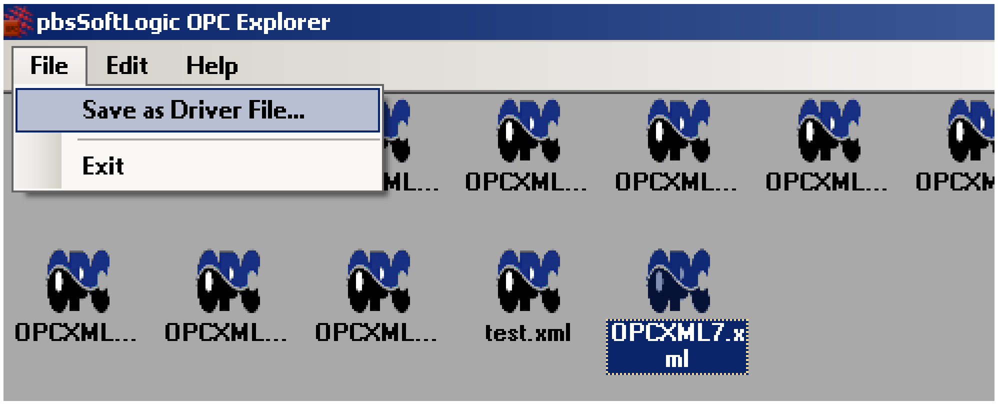
Instance:
Instance number is same as driver instance number.

For saving configuration , click on configuration name and save it by right click menu .



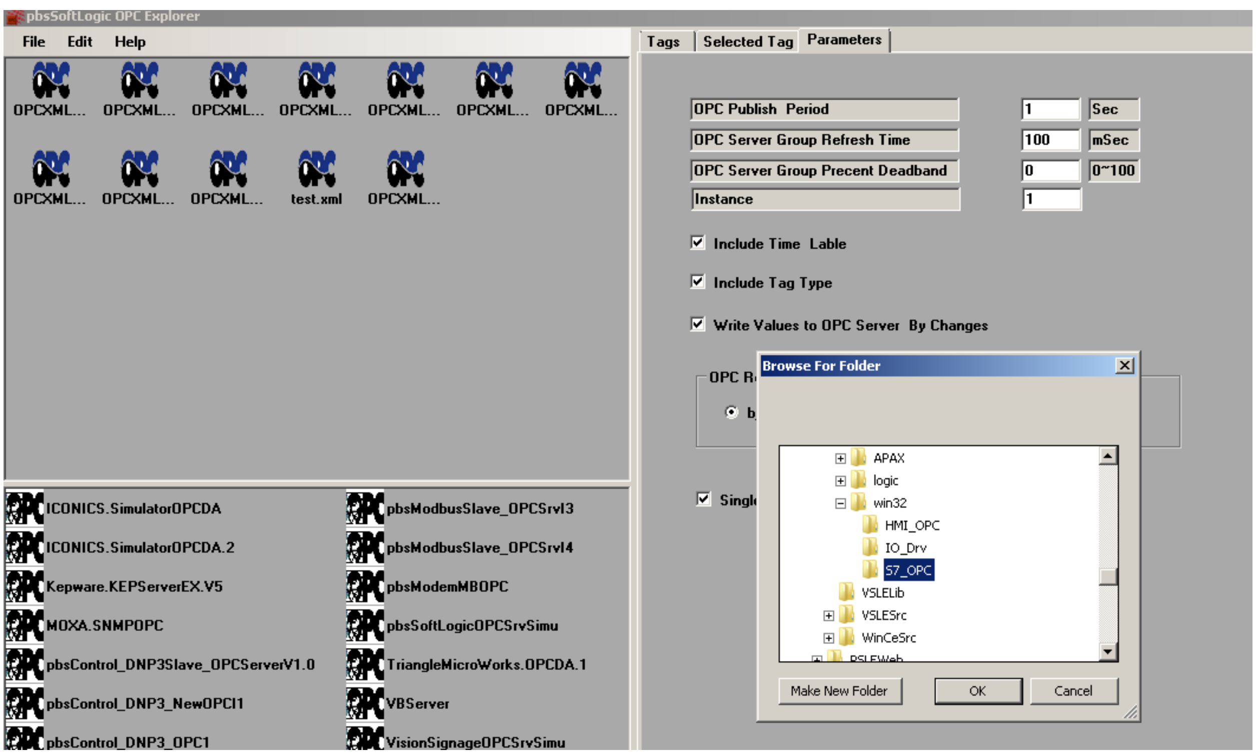
OPC configuration file will be saved at \psle\OPC directory. This file is same file that is used in OPC client driver configuration.

For saving OPC configuration as OPC driver configuration, at “file” menu, select “Save as Driver File”



Save and close configuration file then run “Save as Driver File…” menu and select Driver path.

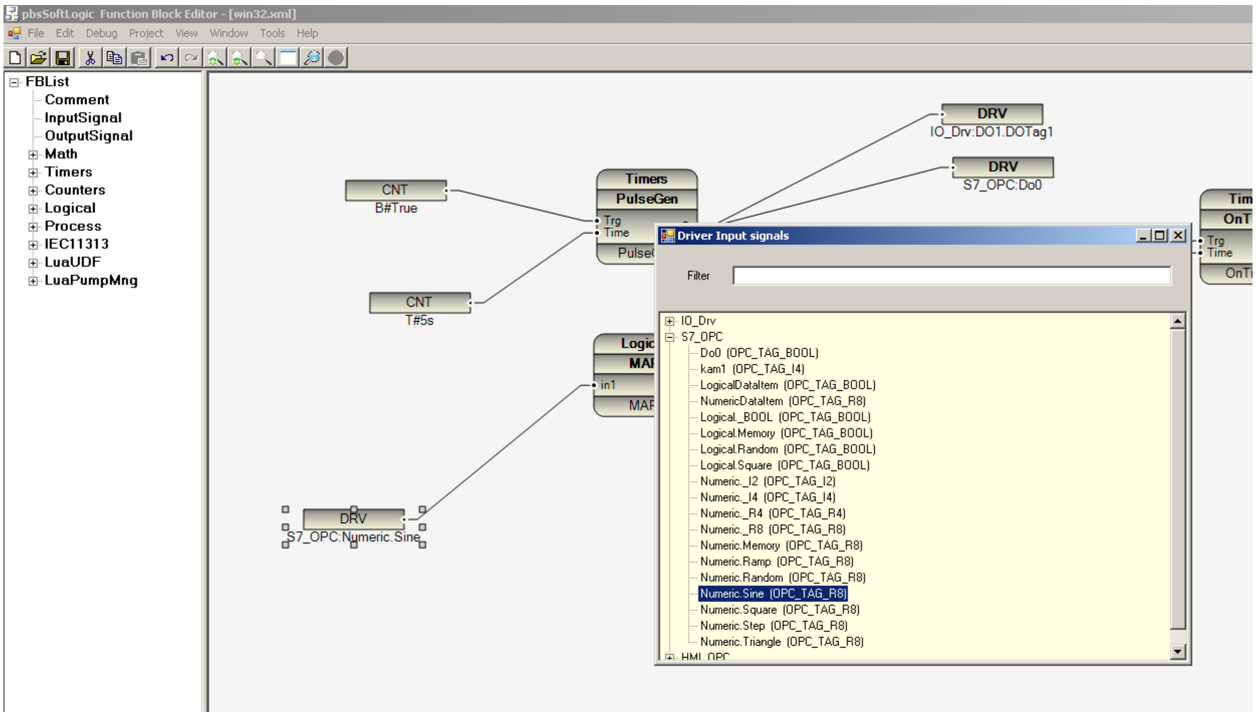
You should select same folder that is made by pbssoftlogic when you define OPC Client driver in project setting page.



It will copy OPC configuration file at driver folder with OPCTags.xml name.

Using OPC Tags in your logic :

- use InputSignal or Outputsignal Elements in your logic
- Right click on Inputsignal or Outputsignal elements
- Select “DRV Signals”
- Select OPC signal from Driver list signals.



- After finish logic , compile logic from “project/compile” menu.
- Transfer configuration file to Controller by “Project/Transfer Configuration” menu.
- Transfer Logic file to controller by “Project/Transfer Logic” menu.
- Restart runtime kernel. (psleWin32RT.exe)

When you transfer Logic and configuration to controller, pbssoftLogic will use following files and change their names as following: (suppose project name is win32)

Win32.lx : it is compiled configuration file will copy to controller and its name changed to logic.cfg

Win32.c11 : it is compiled logic file will copy to controller and its name changed to logic.c11

OPC client Driver runtime specifications:

- Remote Server name: 128 characters

- OPC server name: 256 characters

- OPC Item name: 128 characters

- OPC Server DA 2.0

- Selected OPC Items will read one time and Driver start time, after that OPC server should write Changes by call back to OPC client Driver.

- Maximum Number of OPC Tags for each instance: 1024

- Maximum Number of OPC instance: 8

14 – pbsSDK :User defined Communication Driver Development .

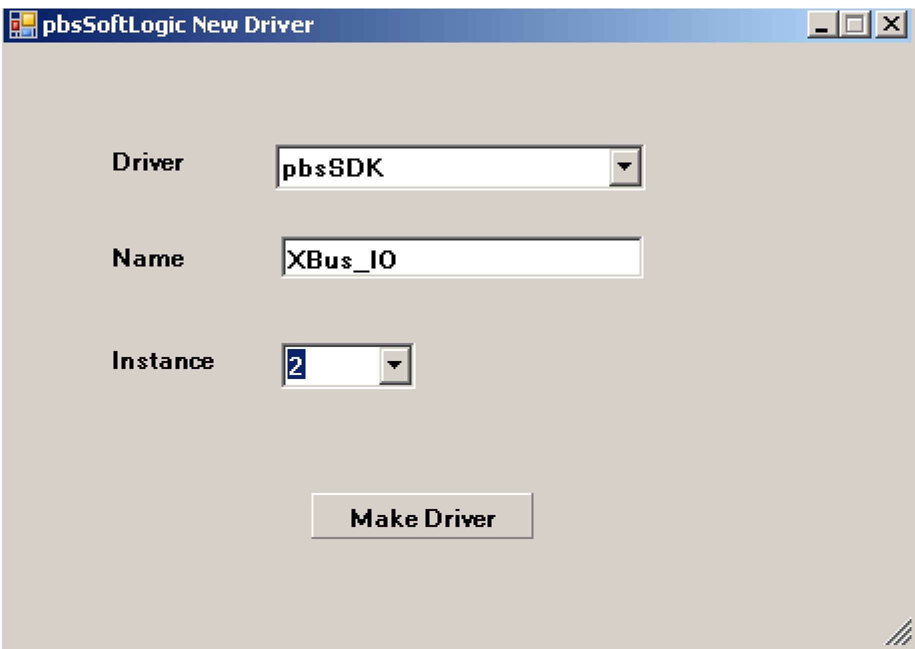
pbsSDK is Software development kit for developing user defined communication protocols in pbsSoftLogic .

If you want to communicate with devices with none standard communication protocols then you need to develop pbsSoftlogic driver by pbsSDK.

For different targets, you need different tools and compilers:

- WinCE: Visual studio 2005 with installed SDK for your hardware. DLL Module.
- Embedded Linux: Eclipse IDE and tool chain for your hardware. Loadable Library SO Module.
- Win32 : Visual studio 2008/2010 . DLL Module

Open project options in project menu. Define new I/O driver and select pbsSDK from driver list.



Suppose name of driver is XBus_IO and it has instance number 2.

You can define unlimited communication protocols by pbsSDK, but only 8 different instances can work on a controller. Suppose in a project you need following driver configuration:

- XBus_IO Instance = 1
- XBus_IO Instance = 2
- YBus_IO Instance = 3
- YBus_IO Instance = 4
- ZBus_IO Instance = 5

XBus , YBus and ZBus are developed based on pbsSDK interface and all of them should have unique Instance number . Following configuration is not correct:

- XBus_IO Instance = 1
- XBus_IO Instance = 2
- YBus_IO Instance = 1
- YBus_IO Instance = 2
- ZBus_IO Instance = 1

Click on “Make Driver” button. pbsSoftlogic will make new directory with XBus_IO in your project and will make two configuration files .

- Options.xml: you should use this file for passing different parameters to your C DLL module.
- pbsSDKTags.xml: will use for defining communications tags for using in your logic.

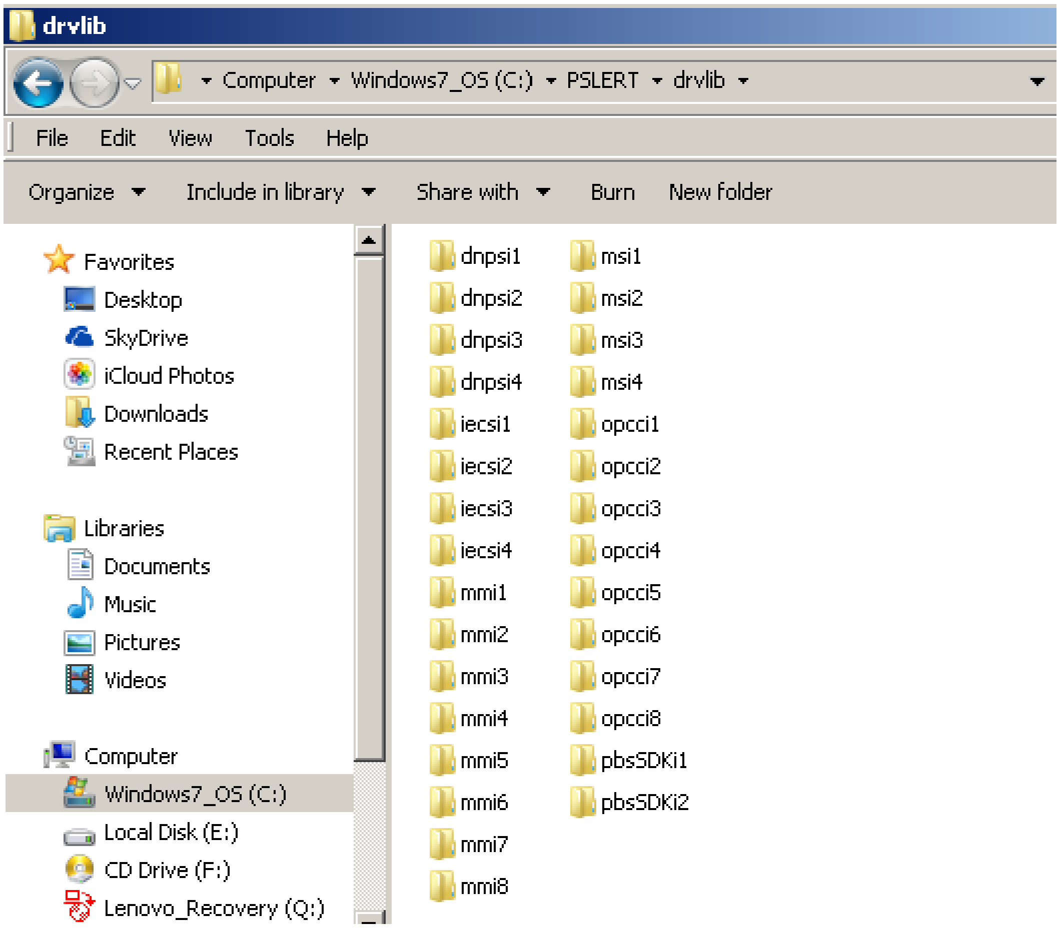
All Tags has same double type in pbsSoftLogic kernel.

Options.xml

```xml
<Options>
    <Version>1.0.0</Version>
    <Node>
        <Name>DriverDirName</Name>
        <Desc>Driver Directory name  Inside Controller</Desc>
        <Value>pbsSDK1</Value>
    </Node>
    <Node>
        <Name>DriverLibName</Name>
        <Desc>Name of Driver Library inside controller</Desc>
        <Value>pbsSDKLib1</Value>
    </Node>
    <Node>
        <Name>Instance</Name>
        <Desc>Instance</Desc>
        <Value>2</Value>
    </Node>
    <Param Name="Param1" Desc="Param1" Value="1" />
    <Param Name="Param2" Desc="Param2" Value="2" />
    <Param Name="Param3" Desc="Param3" Value="3" />
    <Param Name="Param4" Desc="Param4" Value="4" />
    <Param Name="Param5" Desc="Param5" Value="5" />
</Options>
```

DriverDirName , DriverLibName and Instance are not optional and all of them must be in options.xml file . Do not remove them and just change their value.

DriverDirName : Name of Directory inside controller . All pbssoftLogic drivers are located at \drvlib\ directory.



Dnpsi{n} = dnp3 slave driver for instance number n

iecsi{n} = iec870-5-101/104 slave driver for instance number n

mmi{n} = modbus master driver for instance number n

msi{n} = modbus slave driver for instance number n

opcci{n} =OPC client driver for instance number n

For pbsSDK driver you can use any name and set name in DriverDirName Parameter. Without I and {n}

Suppose you will name XBus_IO Driver directory as XBus : DriverDirName = XBus

Then you should make a directory inside \drvlib\ with XBusi1 for instance 1 .

DriverLibName: name of library inside \drvlib\XBusi1\ directory . Suppose your DLL name is XBUS.dll then you should change its name to XBusi1.dll and copy it inside \drvlib\XBusi1

For instance 3 you need following directory and library name:

\drvlib\xbusi3\xbusi3.dll

Instance: Driver instance number.

Param Tags are used for passing parameters to your driver. You can define any number of parameters and its format is under you control. pbsSoftLogic will pass all these parameters as string to runtime kernel and to your driver . So you can consider any format for parameters and their value.

Suppose XBus driver wants to communicate with two Devices (xbus is master and devices are slave) through RS485 and each device has unique ID .

You can set Parameters as following:

```
<Param Name="ComPort" Desc="Serial Communication Port Number " Value="1"/>
<Param Name="BaudRate" Desc="Communication BaudARte" Value="19200"/>
<Param Name="Mode" Desc="RS232-RS485-RS422" Value="RS485"/>
<Param Name="Parity" Desc="Even-Odd-None" Value="None"/>
<Param Name="ScanTime" Desc="Scan Time msec" Value="100"/>

<Param Name="Device1.System.ID" Desc="Device1.ID" Value="1"/>
<Param Name="Device1.Block1.Type" Desc="Device1.Block1.Type" Value="DI"/>
<Param Name="Device1.Block1.StartAdd" Desc="Device1.Block1.Startadd" Value="0"/>
<Param Name="Device1.Block1.Channels" Desc="Device1.Block1.Channels" Value="64"/>

<Param Name="Device1.Block2.Type" Desc="Device1.Block2.Type" Value="AI"/>
<Param Name="Device1.Block2.StartAdd" Desc="Device1.Block2.Startadd" Value="0"/>
<Param Name="Device1.Block2.Channels" Desc="Device1.Block2.Channels" Value="16"/>


<Param Name="Device2.System.ID" Desc="Device2.ID" Value="2"/>
<Param Name="Device2.Block1.Type" Desc="Device2.Block1.Type" Value="DO"/>
<Param Name="Device2.Block1.StartAdd" Desc="Device2.Block1.Startadd" Value="0"/>
<Param Name="Device2.Block1.Channels" Desc="Device2.Block1.Channels" Value="64"/>

<Param Name="Device2.Block2.Type" Desc="Device2.Block2.Type" Value="AO"/>
<Param Name="Device2.Block2.StartAdd" Desc="Device2.Block2.Startadd" Value="0"/>
<Param Name="Device2.Block2.Channels" Desc="Device2.Block2.Channels" Value="16"/>
```

pbsSoftLogic runtime kernel inside controller will pass all parameters with their value as string to user defined communication driver before initializing driver .

so you can easily detect communication parameters and device specifications insider your deriver.

You can find sample driver code for above configuration in \psbssoftlogic\sdk directory.

pbsSDKtags.xml

You should define driver Tags in this file. As an example look at following tag definition:

```
<Version>1.0.0</Version>
<Tag Name="Device1.Block1.Tag1" Init="0" Address="1" />
<Tag Name="Device1.Block1.Tag2" Init="0" Address="2" />
<Tag Name="Device1.Block1.Tag3" Init="0" Address="3" />
<Tag Name="Device1.Block1.Tag4" Init="0" Address="4" />
<Tag Name="Device2.Block1.Tag5" Init="0" Address="5" />
<Tag Name="Device2.Block1.Tag6" Init="0" Address="6" />
<Tag Name="Device2.Block2.Tag7" Init="0" Address="7" />
<Tag Name="Device2.Block2.Tag8" Init="0" Address="8" />
```

Name format is under your control and you can select any format for tag name.

Address is Tag address and its type is int .

Init is Tag Init Value and its type is double.

You can define maximum 1024 Tags for each instance.

Driver C Interface for win32 and WinCE: for win32 and WinCE you need to make DLL module with following interface:

```
extern "C"
{
__declspec(dllexport) int  pbsInit();
__declspec(dllexport) void pbsDown();
__declspec(dllexport) int pbsAddTag( char * pTagName ,double pInitValue ,int pAddress  );
__declspec(dllexport) void pbsWriteTag(int pTagh  , double  pTagvalue );
__declspec(dllexport) void pbsReadTag(int pTagh  , double *  pTagvalue);
__declspec(dllexport) void pbsSetParamValueByName(char * pName ,  char * pParamValueStr);
};
```

1 - pbsSoftlogic runtime kernel will pass all parameters by pvsSetParamValueByName to your DLL Module .

2 – Driver tags will add to DLL module by pbsAddTag Function. This function will return Tag handle that runtime kernel will use it for Read/Write operation.

3 – Kernel will call pbsInit() function .

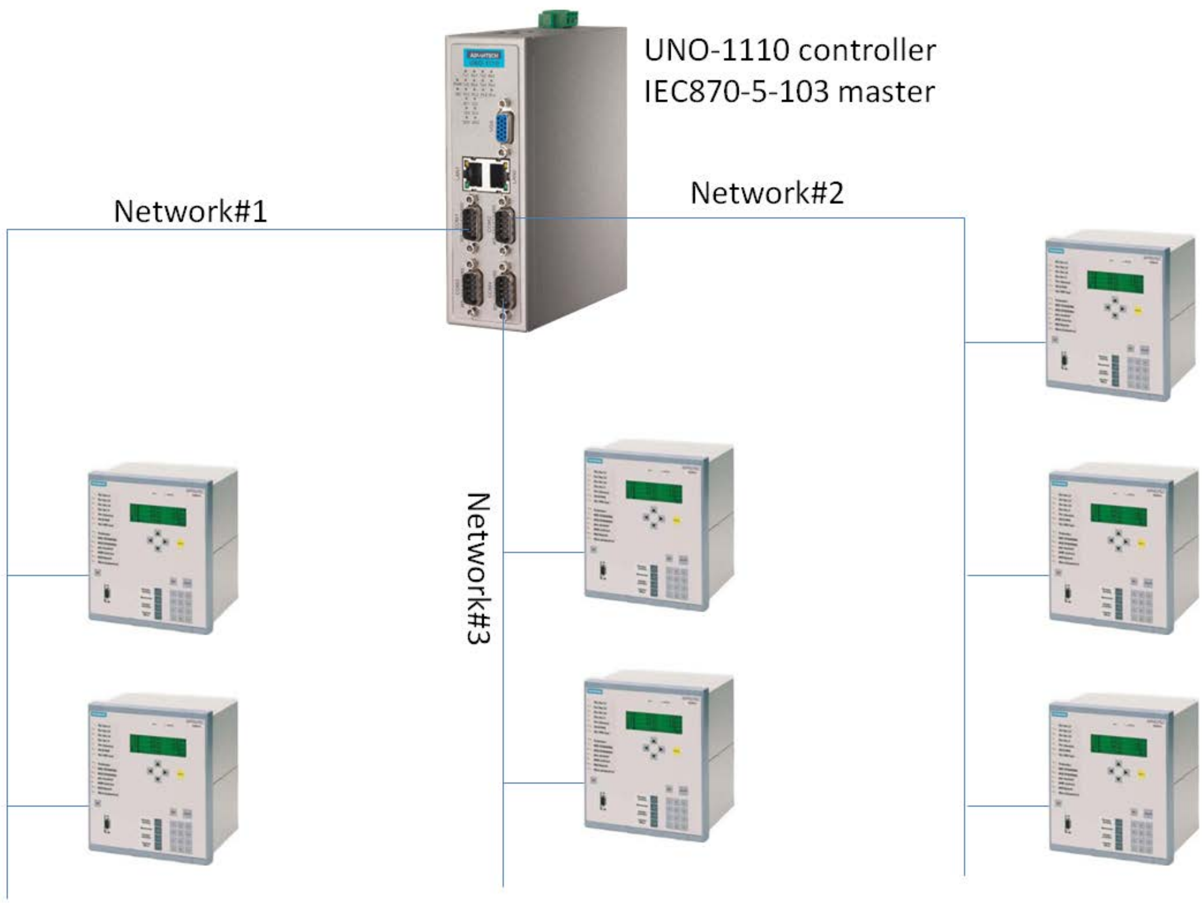
4 – Kernel will read /Write Tags in each Logic circle by pbsReadTag and pbsWriteTag functions.

You can find sample code for Win32 /WinCE and Linuc kernel at \pbssoftlogic\SDK directory.

15 – IEC870-5-103 Master Driver Configuration.

pbsSoftlogic version 1.6.5 supports IEC870-5-103 master protocol for communication with protection relays .

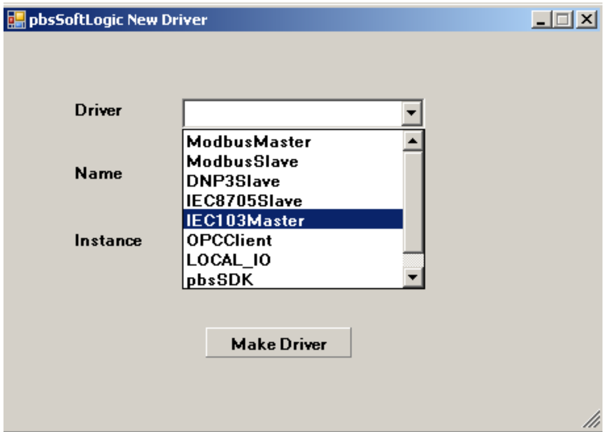
Up to 8 networks can be configured for a controller to communicate with different protection relays.



For each network, you can define up to 1024 IEC tags.

Defining IEC870-5-103 master driver in pbsSoftLogic :

- open project option page
- right click on Driver list and select IEC103Master Driver



-
- Write unique driver name and select Instance. Instance number is between 1 and 8 and shows IEC103 Network number.
- Click on make driver button.
- pbsSoftLogic will make default configuration files at driver directory for current project .
    - options.xml communication parameters settings
    - IEC103Devices.xml IEC103 slave device configuration and Tags

Options.xml file content:

```xml
<Options>
    <Node>
        <Name>COMPort</Name>
        <Desc>Serial Port for Communication 1,2,3,4,5,...</Desc>
        <Value>3</Value>
    </Node>
    <Node>
        <Name>BaudRate</Name>
        <Desc>9600,19200,36400,52700,115200</Desc>
        <Value>9600</Value>
    </Node>
    <Node>
        <Name>DataBit</Name>
        <Desc>7,8</Desc>
        <Value>8</Value>
    </Node>
    <Node>
        <Name>StopBit</Name>
        <Desc>1,2</Desc>
        <Value>1</Value>
    </Node>
    <Node>
        <Name>Parity</Name>
        <Desc>None,Even,Odd</Desc>
        <Value>Even</Value>
    </Node>
    <Node>
        <Name>Instance</Name>
        <Desc>Instance</Desc>
        <Value>1</Value>
    </Node>
</Options>
```

IEC103Devices.xml file content

```
<Devices>
    <Device Name="Relay8" Address="8" ResetLinkFC="0" PollPeriod="300" CommTimeOutSecSP="15" SendGIPeriod="600">
        <IEC103Tags>
            <Tag Name="TimeTagMsg1" TypeInd="1" FunType="40" InfNum="1" Position="0" />
            <Tag Name="TimeTagMsg2" TypeInd="1" FunType="40" InfNum="2" Position="0" />
            <Tag Name="TimeTagMsg3" TypeInd="1" FunType="40" InfNum="3" Position="0" />
            <Tag Name="TimeTagMsg4" TypeInd="1" FunType="40" InfNum="4" Position="0" />
            <Tag Name="TimeTagMsg5" TypeInd="1" FunType="40" InfNum="5" Position="0" />
            <Tag Name="TimeTagMsg6" TypeInd="1" FunType="40" InfNum="6" Position="0" />
            <Tag Name="TimeTagMsg7" TypeInd="1" FunType="40" InfNum="7" Position="0" />
            <Tag Name="TimeTagMsg8" TypeInd="1" FunType="40" InfNum="8" Position="0" />
            <Tag Name="MeasurandI1" TypeInd="3" FunType="160" InfNum="145" Position="0" />
            <Tag Name="MeasurandI2" TypeInd="3" FunType="160" InfNum="145" Position="1" />
            <Tag Name="MeasurandI3" TypeInd="3" FunType="160" InfNum="145" Position="2" />
            <Tag Name="MeasurandI4" TypeInd="3" FunType="160" InfNum="145" Position="3" />
            <Tag Name="MeasurandI5" TypeInd="3" FunType="160" InfNum="145" Position="4" />
            <Tag Name="MeasurandI6" TypeInd="3" FunType="160" InfNum="145" Position="5" />
            <Tag Name="MeasurandI7" TypeInd="3" FunType="160" InfNum="145" Position="6" />
            <Tag Name="MeasurandI8" TypeInd="3" FunType="160" InfNum="145" Position="7" />
            <Tag Name="MeasurandII1" TypeInd="9" FunType="134" InfNum="146" Position="0" />
            <Tag Name="MeasurandII2" TypeInd="9" FunType="134" InfNum="146" Position="1" />
            <Tag Name="MeasurandII3" TypeInd="9" FunType="134" InfNum="146" Position="2" />
            <Tag Name="MeasurandII4" TypeInd="9" FunType="134" InfNum="146" Position="3" />
            <Tag Name="MeasurandII5" TypeInd="9" FunType="134" InfNum="146" Position="4" />
            <Tag Name="MeasurandII6" TypeInd="9" FunType="134" InfNum="146" Position="5" />
            <Tag Name="MeasurandII7" TypeInd="9" FunType="134" InfNum="146" Position="6" />
            <Tag Name="MeasurandII8" TypeInd="9" FunType="134" InfNum="146" Position="7" />
        </IEC103Tags>
    </Device>
</Devices>
```

For each protection relay on a network, you should define one <Device> Tag.

<Device> Name Attribute: for each Relay in a network, you should consider unique name

<Device> address: Data Link layer and ASDU Address of relay.

<Device> ResetLinkFC : shows which Function code is use for resting communication with relay . 0 or 7

<Device> PollPerid : shows period of sending class1 or class2 request to relay in msec . IEC103 driver is sending one class1 request for reading events and one class2 request for reading analog signals periodically.

<Device> CommTimeoutSecSP : shows after how many sec , driver will reset and reinitialized communication with relay when there is no communication with relay .

<Device>SendGIPeriod : Shows after how many min , IEC103 driver will send GI command to relay .

<IEC103Tags><Tag> Name : Unique name for a tag in a device .

<IEC103Tags><Tag> TypeInd :

- TYPE IDENTIFICATION 1: Time-tagged message
- TYPE IDENTIFICATION 2: Time-tagged message with relative time
- TYPE IDENTIFICATION 3: Measurands I
- TYPE IDENTIFICATION 9: Measurands II

<IEC103Tags><Tag>Funtype: Function Type for tag. Please refer to relay IEC103 documentation for detail function types.

<IEC103Tags><Tag>InfNum: Information Number for tag. Please refer to relay IEC103 documentation for detail Information Number.

<IEC103Tags><Tag> Position : Position of analog signal in MEASURANDS I and II . Starting from 0.

Sample IEC103 Tags from Siemens 7SK80 Series Relay:

No.	Description	Function	IEC 60870-5-103					Configurable in Matrix		
			Type	Information Number	Compatibility	Data Unit	Position	CFC	Control Display	Default Display
-	Number of TRIPs= (#of TRIPs=)	Statistics	-	-	-	-	-	CFC		
-	Operating hours greater than (OpHour>)	SetPoint(Stat)	-	-	-	-	-	CFC		
601	Ia (Ia =)	Measurement	134	157	No	9	1	CFC		
602	Ib (Ib =)	Measurement	160	145	Yes	3	1	CFC		
			134	157	No	9	2			
603	Ic (Ic =)	Measurement	134	157	No	9	3	CFC		
604	In (In =)	Measurement	134	157	No	9	4	CFC		
605	I1 (positive sequence) (I1 =)	Measurement	-	-	-	-	-	CFC		
606	I2 (negative sequence) (I2 =)	Measurement	-	-	-	-	-	CFC		
621	Va (Va =)	Measurement	134	157	No	9	6	CFC		
622	Vb (Vb =)	Measurement	134	157	No	9	7	CFC		
623	Vc (Vc =)	Measurement	134	157	No	9	8	CFC		
624	Va-b (Va-b=)	Measurement	160	145	Yes	3	2	CFC		
			134	157	No	9	9			
625	Vb-c (Vb-c=)	Measurement	134	157	No	9	10	CFC		
626	Vc-a (Vc-a=)	Measurement	134	157	No	9	11	CFC		
627	VN (VN =)	Measurement	134	118	No	9	1	CFC		

pbssoftLogic Tag definition for some above relay signals :

<Tag Name="Ia" TypeInd="9" FunType="134" InfNum="157" Position="0" />

<Tag Name="Ib" TypeInd="3" FunType="160" InfNum="145" Position="0" />

<Tag Name="Ic" TypeInd="9" FunType="134" InfNum="157" Position="2" />

<Tag Name="Va" TypeInd="9" FunType="134" InfNum="157" Position="5" />

<Tag Name="VN" TypeInd="9" FunType="134" InfNum="118" Position="0" />

Sample IEC103 tags from Siemens 7sk80 series relay:

3.2.1 Automatic reclosure status

ASDU	Function type	Informa-tion number	Name	Description	Obj. - Adr.
1	40	1	>79 ON	>79 ON; Automatic reclosure ON; ON = 1, OFF = 0	2701
1	40	2	>79 OFF	>79 OFF; ON = 1, OFF = 0	2702
1	40	3	> BLOCK 79	>BLOCK 79; ON = 1, OFF = 0	2703
2	40	15	>Start 79 Gnd	>Start 79 Ground programm; ON = 1, OFF = 0	2715
2	40	16	>Start 79 Ph	>Start 79 Phase programm; ON = 1, OFF = 0	2716
1	40	20	>Enable ANSI#-2	>Enable 50/67-(N)-2 (override 79 blk); ON = 1, OFF = 0	2720
1	40	30	>CB Ready	>Circuit breaker READY for reclosing; ON = 1, OFF = 0	2730
1	40	81	79 OFF	79 Auto recloser is switched OFF; ON = 1, OFF = 0	2781
2	40	85	79 DynBlock	79 – Auto-reclose is dynamically BLOCKED; ON = 1, OFF = 0	2785
1	40	101	79 in progress	79 – in progress; ON = 1, OFF = 0	2801
1	40	162	79 Successful	79 – cycle successful; ON = 1, OFF = 0	2862
2	40	163	79 Lockout	79 – Lockout; ON = 1, OFF = 0	2863
2	40	180	79 L_N Sequence	79-A/R single phase reclosing sequence; Program earthfault is running = 1, Program is deactivated = 0	2878
2	40	181	79 L-L Sequence	79-A/R multi-phase reclosing sequence; ON = 1, OFF = 0	2879
1	160	16	79 ON	79 Auto recloser is switched ON; ON = 1, OFF = 0	2782
1	160	128	79 Close	79 – Close command; ON = 1	2851

pbssoftLogic Tag definition for some above relay signals :

```
<Tag Name="79_ON" TypeInd="1" FunType="40" InfNum="1" Position="0" />

<Tag Name="79_OFF" TypeInd="1" FunType="40" InfNum="2" Position="0" />

<Tag Name="79_Block" TypeInd="1" FunType="40" InfNum="3" Position="0" />

<Tag Name="79_Start_Gn" TypeInd="2" FunType="40" InfNum="15" Position="0" />

<Tag Name="79_Successful" TypeInd="1" FunType="40" InfNum="162" Position="0" />
```

IEC103 master driver runtime operation:

When IEC103 master driver starts, it will do following sequence:

- send INIT command to relay (FC = 0 or FC = 7)
- Sending Class1 request until getting Identification message ASDU = 5 , COT = resetCU or ResetFCB
- Send Time Synchronization command to relay TYPE ID = 6 , COT = 8
- Send GI Command
- Sending Class1 Request until getting ASDU = 8 , COT = End of GI
- Send Class 2 for reading analog signals
- Send Class 1 for reading Events
- Send Class 2 for reading analog signals
- Send Class 1 for reading Events
- If it is time for sending GI command , send GI command
- If there is no communication from relay side after COMMTimeOutSecSP Sec , make relay offline and try to initialize relay and repeat above sequence

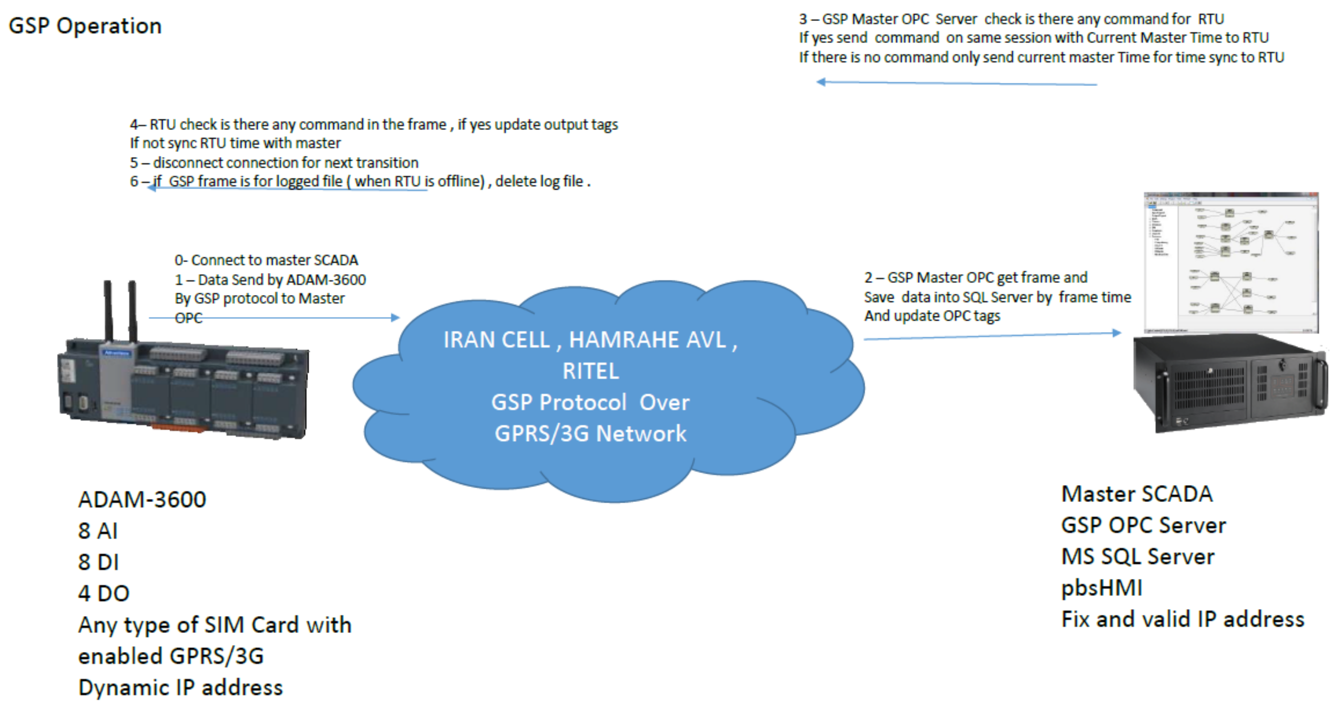
Note : In current version of IEC103 master driver , Sending Set points and commands are not supported. So you can use IEC103 driver just for reading events and analog signals for monitoring purpose from relay.

16 – GSP Client Driver Configuration

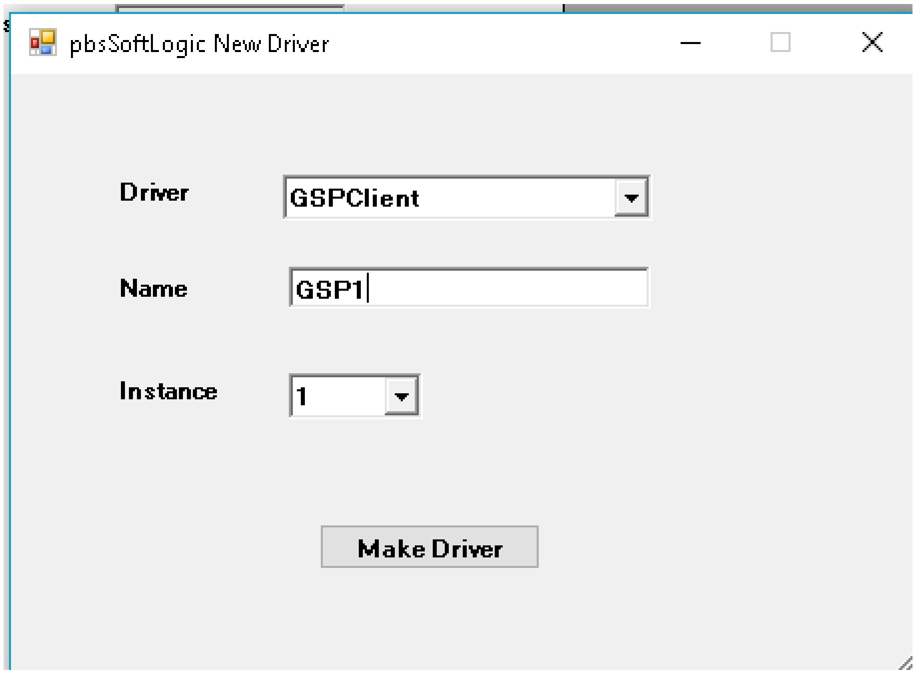
User should know GSP protocol concepts for proper using of GSP Driver. For detail Information about GSP protocol please refer to GSP specification documentation. http://pbscontrol.com/pdf/gsp_spec.pdf

GSP (GPRS/3G for SCADA Projects) protocol is developed for SCADA systems which has following specification :

- There is no stable communication media between RTUs and Master SCADA.
- RTU has dynamic IP address.
- There is only one Valid and static IP address for master SCADA.
- Time Synchronization is required between master SCADA and RTUS.
- Local Data buffering in RTU is required when Communication is offline and sending logged data to SCADA master after establishing connection.
- Number of total I/O for transition between RTU and Master SCADA is not more than 600 Tags
- There are many RTUs in Project. GSP is designed for SCADA with huge number of RTUs.
- Target project for GSP is power and gas distribution SCADA.
- RTU has low Resources (No need for powerful CPU and too much RAM)



Define a new Driver for your project and select GSPClient Driver.



Select a unique name for driver. Click on make driver. pbsSoftLogic will make default configuration for you . pbsSoftLogic will make two configuration file in driver directory .

Options file:

MasterIPAddress : Master IP address for sending GSP frame to SCADA server . We developed Free GSP OPC Server for master SCADA which you need to install it at master.

RTUID : Each RTU should has unique Numeric ID (1 , 2, 3, ..) for communication with master SCADA . Maximum ID can be 65535.

TCPPort : TCP Communication port . It should be same value for all RTUs and Master OPC server. You need to unblock this port number in your network for proper communication. Please refer to your IT team to assign one TCP port for your project.

SendGSPPeriod : RTU will send data based on this time . If value is less than 60 , it will send every n sec , but if it is more than 60 , it will send exactly on Every n Min . Suppose you set this parameter to 300. Then it will send exactly on following time xx:0 ,xx:5 , xx:10 , xx:15 ,xx:20 ,xx:25 , xx:30 , xx:35 , xx:40 , xx:45 ,xx:50 , xx:55 ,xx+1:0,...

SendbyChanges : RTU Will send data when SendByChange SYS tag is triggered to high .

LogPath : if RTU couldn't send GSP frame to master SCADA for 3 times retry , then it will save GSP frame in a local binary file which is located In LogPath . For example /home/gspdata/

Every time communication established to master SCADA, GSP will send all saved file to Master OPC Server. This Directory should be created in RTU.

OfflineSec : if RTU couldn't communicate with master SCADA in OfflineSec , then CommOnline Signal will change to 0 . When RTU has connection with Master SCADA CommOnline has value 1 .

You can restart RTU when CommOnline is dropped to 0 especially when GPRS/3G is using for communication with master SCADA.

GSPTags.xml file

pbsSoftLogic supports GSP client driver , so it is like Slave drivers . you need to define Tags and Write input tags and read Output Tags in your logic.

In following figure you can see different types of GSP tags :

```xml
<?xml version="1.0"?>
<OPCSrvTags>
    <Version>1.0.0</Version>
    <Tag Name="SendByChange" Type="SYS" Init="0" Address="0" Log="0" />
    <Tag Name="CommOnline" Type="SYS" Init="0" Address="1" Log="0" />
    <Tag Name="SaveByChange" Type="SYS" Init="0" Address="2" Log="0" />
    <Tag Name="NumOfLogFiles" Type="SYS" Init="0" Address="3" Log="0" />
    <Tag Name="DITag1" Type="DI" Address="1" Init="0" Log="0" />
    <Tag Name="DITag2" Type="DI" Address="2" Init="0" Log="0" />
    <Tag Name="DITag3" Type="DI" Address="3" Init="0" Log="0" />
    <Tag Name="DITag9" Type="DI" Address="9" Init="0" Log="0" />
    <Tag Name="AITag1" Type="AI" Address="1" Init="0" Log="0" />
    <Tag Name="AITag2" Type="AI" Address="2" Init="0" Log="0" />
    <Tag Name="AITag3" Type="AI" Address="3" Init="0" Log="0" />
    <Tag Name="AITag4" Type="AI" Address="4" Init="0" Log="0" />
    <Tag Name="AITag8" Type="AI" Address="8" Init="0" Log="0" />
    <Tag Name="AITag9" Type="AI" Address="9" Init="0" Log="0" />
    <Tag Name="AITag10" Type="AI" Address="10" Init="0" Log="0" />
    <Tag Name="FITag1" Type="FI" Address="1" Init="0" Log="0" />
    <Tag Name="FITag2" Type="FI" Address="2" Init="0" Log="0" />
    <Tag Name="FITag3" Type="FI" Address="3" Init="0" Log="0" />
    <Tag Name="FITag4" Type="FI" Address="4" Init="0" Log="0" />
    <Tag Name="LITag1" Type="LI" Address="1" Init="0" Log="0" />
    <Tag Name="LITag2" Type="LI" Address="2" Init="0" Log="0" />
    <Tag Name="LITag3" Type="LI" Address="3" Init="0" Log="0" />

</OPCSrvTags>
```

First four tags are system tags. Please do not change name, type and address.

SendByChange : When Change from 0 to 1 in your logic , GSP Driver provide GSP frame and start to send to server .

CommOnLine : When GSP Driver is sending Frames to Master and getting answer from master , CommOnLine is set to 1 . If OfflineSec is passed and GSP driver couldn't send any frame to master , CommOnline will change to 0 .

SaveByChange : When Change from 0 to 1 in logic , GSP Driver is reading current value of GSP Tags and save them in RTU Flash for sending to Master based on scheduling that is set for driver . SaveByChange only save data as back fill file and not start communicating with master.

NumOfLogFiles : shows number of Back fill Files in RTU . You can send this value to Master and use it in Modem Off/ON Logic . Suppose when number of Back Fill files are more than 20 , then make 3G Modem On until all Back fill files are transferred to Master .

There are following Tag types in GSP:

DI = Digital Input

AI = Analog Input (2 byte Signed)

FI = Float Input (4 Bytes)

LI = Long Input (4 Bytes Signed)

ULI = Unsigned long (4 Bytes Unsigned)

DO = Digital Output

AO = Analog Output (2 Bytes, Signed)

Each Tag Type has an address which is start from 1 and end with 64. So you can define maximum 64 tags from each type. Please notice that GSP is designed for distribution SCADA projects which has a lot of RTU but with small number of signals for communications.

Log: if you set Log to 1, last value of Signal will log to RTU flash (Persistent Tag) .

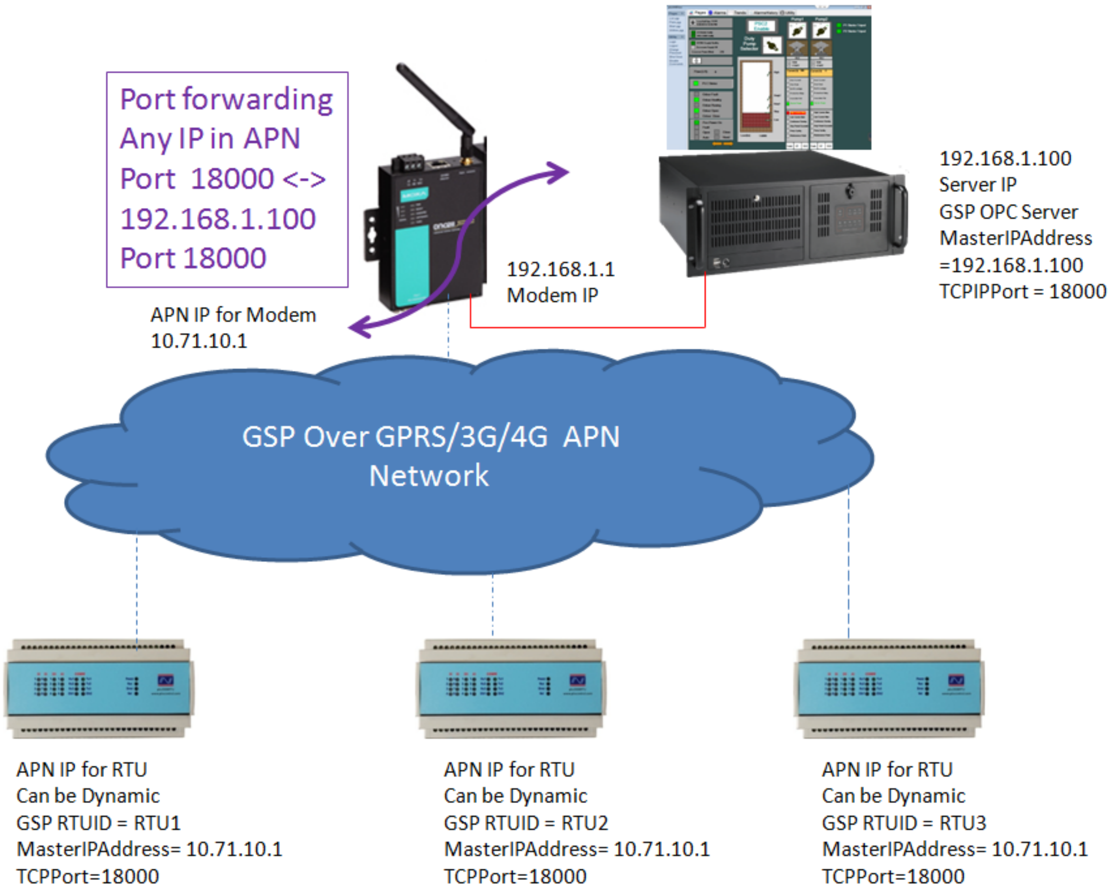
GSP Operation: when Driver detects Communication time, it will first connect to Master SCADA. If RTU can connect, it will send all tags to master by GSP frame format. When Master OPC server got frame, it will send server time and check is operator forced any Do or AO signals? If there is Forced Output signal, Master Will sends Time and DO and AO commands to RTU. If there is no any Output command, Master is only send Time for synchronization between Master and RTU.

When RTU received correct answer, it will close connection with master.

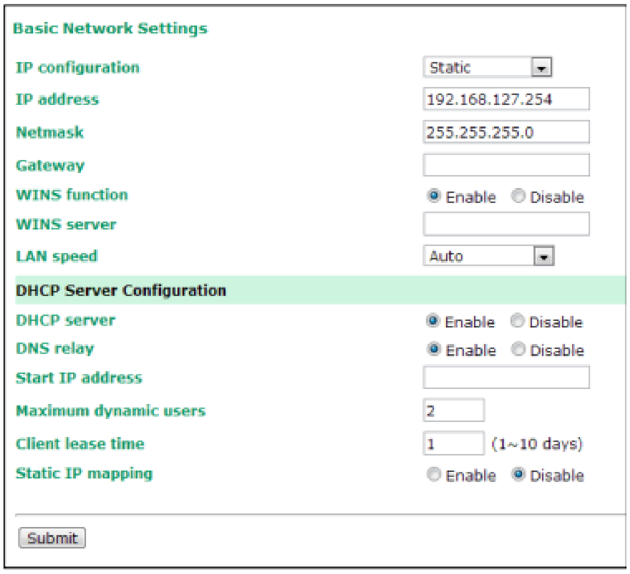
Because each transaction starts from RTU, So we don't need Fix IP address in RTU. Only RTU ID is enough.

Configuration of Sample system based on 3G Network

- Suppose you are using APN for SCADA Communication
- In master SCADA you have 3G Modem Like MOXA Oncell3151.
- There are 3 pbs2008RTU at site and need to communicate with Master SCADA by GSP Protocol . As following Diagram



- Suppose you are using TCP port number 18000 for GSP Communication . Set GSP Parameter “TCPPort” to 18000
- When Setting GSP Driver parameter , you need to set APN IP of MOXA 3G Modem for each RTU as “MasterIPAddress” parameter .
- Give unique name for each RTU in “RTUID” parameter.
- In MOXA OnCel3151 enable DHCP Server functionality.



-
- Set DHCP Server , Start IP Address and Maximum dynamic Users .
- Enable Static IP mapping and Configure Modem to give always static IP address Like 192.168.1.100 to SCADA Server .
- Define port forwarding in MOXA Modem , forward all TCP frames that is coming from APN with port Number 18000 will map to SCADA Server (IP = 192.168.1.100) by same port 18000 .
- Download and install GSP Master OPC Server from www.pbscontrol.com on SCADA Server .
- When you configure GSP OPC Server set IP address of Server in “MasterIPAddress” parameter(192.168.1.100) and set “TCPIPPort” to 18000 .

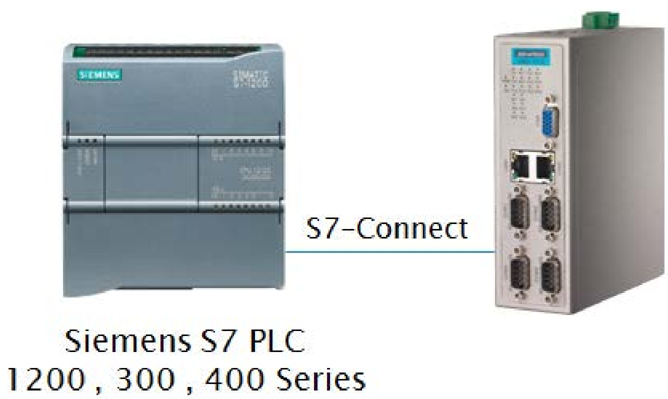
17 – S7 Communication Driver Configuration .

pbsSoftLogic supports Siemens S7-Communication protocol for Read/Write Tags from/To all S7 Series PLCs .

pbssoftLogic supports Client side for S7-Communication protocol .

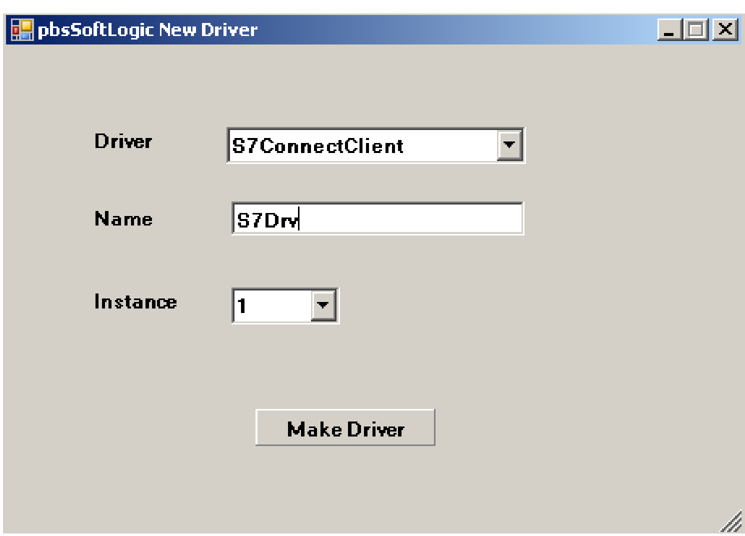
S7-communication works on TCP connection and your Siemens PLC should have IP address.

S7-Connect driver is not working with MAC ID of PLC.



Defining S7 Client in pbsSoftLogic :

- Define a new deriver and select S7ConnectClient



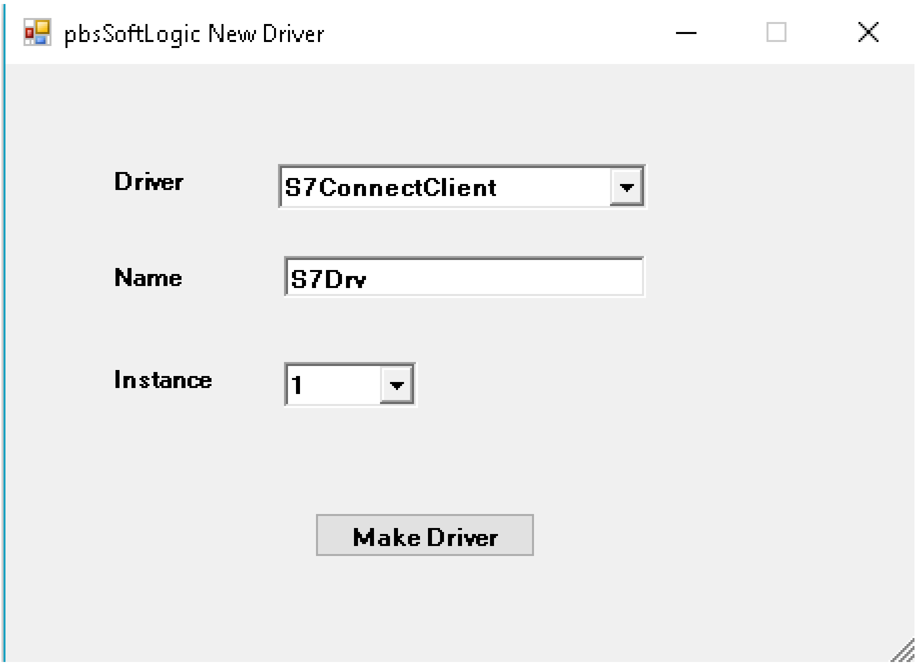
Select a unique name for driver and select Driver Instance.

If you want to connect to more than one S7 PLC, define a new S7ConnectClient for each PLC. Click on Make Driver, pbsSoftLogic will make a new directory (Driver name) and make default configuration file there.

You need to enable S7communication protocol on your PLC. pbsSoftLogic S7 Driver can read/write following type of information from S7 Series PLCs:

- Data Block
- Process Input / Output
- Memory

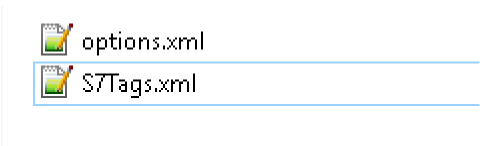
For defining a new S7 Driver for your project, in new Driver Page select s7ConnectClient Driver.



Select a unique name for driver and select Instance. When you have more than one PLC you need to define one S7Connect Driver for each PLC with different instance number.

You can connect maximum 8 PLC to pbsSoftLogic based RTU.

When you make a new driver, pbsSoftlogic will make default configuration files in your project.



Options.xml file:

```xml
<Options>
      <Node>
            <Name>PLCIP</Name>
            <Desc>PLC IP address</Desc>
            <Value>192.168.10.81</Value>
      </Node>
      <Node>
            <Name>Rack</Name>
            <Desc>PLC Rack</Desc>
            <Value>0</Value>
      </Node>
      <Node>
            <Name>Slot</Name>
            <Desc>PLC Slot</Desc>
            <Value>1</Value>
      </Node>
      <Node>
            <Name>BlockScanTime</Name>
            <Desc>BlockScanTime(ms)</Desc>
            <Value>50</Value>
      </Node>
      <Node>
            <Name>Instance</Name>
            <Desc>Instance</Desc>
            <Value>1</Value>
      </Node>
</Options>
```

PLCIP: IP address of S7 PLC

RACK, Slot: you need to find these numbers from your PLC Configuration application.

	Rack	Slot	
S7 300 CPU	0	2	Always
S7 400 CPU	Not fixed		Follow the hardware configuration.
WinAC CPU	Not fixed		Follow the hardware configuration.
S7 1200 CPU	0	0	Or 0, 1
S7 1500 CPU	0	0	Or 0, 1
CP 343	0	0	Or follow Hardware configuration.
CP 443	Not fixed		Follow the hardware configuration.
WinAC IE	0	0	Or follow Hardware configuration.

BlockScanTime: Scan time of reading/Writing to PLC In millisecond

S7Tags.xml file:

You need to define S7 Tags in this file. pbsSoftlogic will define for you all different supported blocks as sample for you when you define a new driver .

SYS block:

```
<Block Name="StatusBlock" Type="SYS" DBNum="0" Start="0" Channels="4">
    <S7Tags>
        <Tag Name="Online" Address="0" Init="0" />
        <Tag Name="ReadNum" Address="1" Init="0" />
        <Tag Name="WriteNum" Address="2" Init="0" />
        <Tag Name="ErrorNum" Address="3" Init="0" />
    </S7Tags>
</Block>
```

This block has 4 Tags: Online and ErrorNum is not used in driver.

ReadNum : Shows number of Read Operation from PLC (from 0 to 32000)

WriteNum: Shows number of Write Operation to PLC (from 0 to 32000)

You need to always check Read or Write Number In your logic. If for any reason RTU lost connection with PLC these number will not changed. And if you detect for example for 5 Sec these numbers are not changed, you will find that PLC connection is Offline and need to restart RTU.

S7Driver can only read/Write in byte format to S7 PLC.

You can define maximum 32 Blocks and in each block 64 Bytes can be read/Write. But total number of tags should not be more than 1024.

DBR Block:

```
<Block Name="Block1" Type="DBR" DBNum="1" Start="0" Channels="8">
    <S7Tags>
        <Tag Name="DB1_0" Address="0" Init="0" />
        <Tag Name="DB1_1" Address="1" Init="0" />
        <Tag Name="DB1_2" Address="2" Init="0" />
        <Tag Name="DB1_3" Address="3" Init="0" />
        <Tag Name="DB1_4" Address="4" Init="0" />
        <Tag Name="DB1_5" Address="5" Init="0" />
        <Tag Name="DB1_6" Address="6" Init="0" />
        <Tag Name="DB1_7" Address="7" Init="0" />
    </S7Tags>
</Block>
```

DBR is using for reading S7 PLC Data Blocks.

DBNum = S7 Data Block Number

Start = Start Byte from Block

Channels: Number of Bytes to be read

In above sample RTU is reading 8 bytes from beginning of Block from DB Number 1.

DBW Block:

```
<Block Name="Block2" Type="DBW" DBNum="2" Start="0" Channels="8">
    <S7Tags>
        <Tag Name="DB2_0" Address="0" Init="0" />
        <Tag Name="DB2_1" Address="1" Init="0" />
        <Tag Name="DB2_2" Address="2" Init="0" />
        <Tag Name="DB2_3" Address="3" Init="0" />
        <Tag Name="DB2_4" Address="4" Init="0" />
        <Tag Name="DB2_5" Address="5" Init="0" />
        <Tag Name="DB2_6" Address="6" Init="0" />
        <Tag Name="DB2_7" Address="7" Init="0" />
    </S7Tags>
</Block>
```

DBW Block is using for writing to S7 PLC Data blocks.

DBNum = S7 Data Block Number

Start = Start Byte from Block

Channels: Number of Bytes to be writes

In above sample RTU is Writing 8 bytes from beginning of Block from DB Number 2.

PI Block: process input

```
<Block Name="Block3" Type="PI" DBNum="0" Start="0" Channels="8">
    <S7Tags>
        <Tag Name="PI_0" Address="0" Init="0" />
        <Tag Name="PI_1" Address="1" Init="0" />
        <Tag Name="PI_2" Address="2" Init="0" />
        <Tag Name="PI_3" Address="3" Init="0" />
        <Tag Name="PI_4" Address="4" Init="0" />
        <Tag Name="PI_5" Address="5" Init="0" />
        <Tag Name="PI_6" Address="6" Init="0" />
        <Tag Name="PI_7" Address="7" Init="0" />
    </S7Tags>
</Block>
```

PI Block will use for reading PLC Input Process Data. Suppose you map 32 digital Inputs and 4 Analog input channels in PLC Process Input Area from Address 10 to 22. Then you can read these channels by following PI block definition:

```
<Block Name="Block3" Type="PI" DBNum="0" Start="10" Channels="12">
    <S7Tags>
        <Tag Name="PI_0" Address="0" Init="0" />
        <Tag Name="PI_1" Address="1" Init="0" />
        <Tag Name="PI_2" Address="2" Init="0" />
        <Tag Name="PI_3" Address="3" Init="0" />
        <Tag Name="PI_4" Address="4" Init="0" />
        <Tag Name="PI_5" Address="5" Init="0" />
        <Tag Name="PI_6" Address="6" Init="0" />
        <Tag Name="PI_7" Address="7" Init="0" />
        <Tag Name="PI_8" Address="8" Init="0" />
        <Tag Name="PI_9" Address="9" Init="0" />
        <Tag Name="PI_10" Address="10" Init="0" />
        <Tag Name="PI_11" Address="11" Init="0" />
    </S7Tags>
</Block>
```

PI_0 , PI_1 , PI_2 and PI_3 has value of 32 digital input channel .

PI_4 /PI_5 = Analog input 1

PI_6 /PI_7 = Analog input 2

PI_8 /PI_9 = Analog input 3

PI_10 /PI_11 = Analog input 4

DBNum = Not used for PI Block.

POR, POW: POR = Read Process Output Status, POW = Write process output

```
<Block Name="Block4" Type="POR" DBNum="0" Start="0" Channels="8">
    <S7Tags>
        <Tag Name="POR_0" Address="0" Init="0" />
        <Tag Name="POR_1" Address="1" Init="0" />
        <Tag Name="POR_2" Address="2" Init="0" />
        <Tag Name="POR_3" Address="3" Init="0" />
        <Tag Name="POR_4" Address="4" Init="0" />
        <Tag Name="POR_5" Address="5" Init="0" />
        <Tag Name="POR_6" Address="6" Init="0" />
        <Tag Name="POR_7" Address="7" Init="0" />
    </S7Tags>
</Block>
<Block Name="Block5" Type="POW" DBNum="0" Start="0" Channels="8">
    <S7Tags>
        <Tag Name="POW_0" Address="0" Init="0" />
        <Tag Name="POW_1" Address="1" Init="0" />
        <Tag Name="POW_2" Address="2" Init="0" />
        <Tag Name="POW_3" Address="3" Init="0" />
        <Tag Name="POW_4" Address="4" Init="0" />
        <Tag Name="POW_5" Address="5" Init="0" />
        <Tag Name="POW_6" Address="6" Init="0" />
        <Tag Name="POW_7" Address="7" Init="0" />
    </S7Tags>
</Block>
```

POR Block will use for reading PLC Output Process Data.

POW Block will use for Writing PLC Output Process Data.

DBNum = Not used for POR, POW Blocks.

Start = Start Address of Process output

Channels: Number of Bytes to Write/Read

In above example RTU is reading Output process area of PLC from address 0 for 8 bytes by Block4 and will write on same area by Block5.

MBR , MBW Blocks :MBR = Read memory Area , MBW = Write memory Area

```xml
<Block Name="Block6" Type="MBR" DBNum="0" Start="0" Channels="8">
    <S7Tags>
        <Tag Name="MBR_0" Address="0" Init="0" />
        <Tag Name="MBR_1" Address="1" Init="0" />
        <Tag Name="MBR_2" Address="2" Init="0" />
        <Tag Name="MBR_3" Address="3" Init="0" />
        <Tag Name="MBR_4" Address="4" Init="0" />
        <Tag Name="MBR_5" Address="5" Init="0" />
        <Tag Name="MBR_6" Address="6" Init="0" />
        <Tag Name="MBR_7" Address="7" Init="0" />
    </S7Tags>
</Block>
<Block Name="Block7" Type="MBW" DBNum="0" Start="0" Channels="8">
    <S7Tags>
        <Tag Name="MBW_0" Address="0" Init="0" />
        <Tag Name="MBW_1" Address="1" Init="0" />
        <Tag Name="MBW_2" Address="2" Init="0" />
        <Tag Name="MBW_3" Address="3" Init="0" />
        <Tag Name="MBW_4" Address="4" Init="0" />
        <Tag Name="MBW_5" Address="5" Init="0" />
        <Tag Name="MBW_6" Address="6" Init="0" />
        <Tag Name="MBW_7" Address="7" Init="0" />
    </S7Tags>
</Block>
```

MBR Block will use for reading PLC memory Area.

PBW Block will use for Writing PLC memory area.

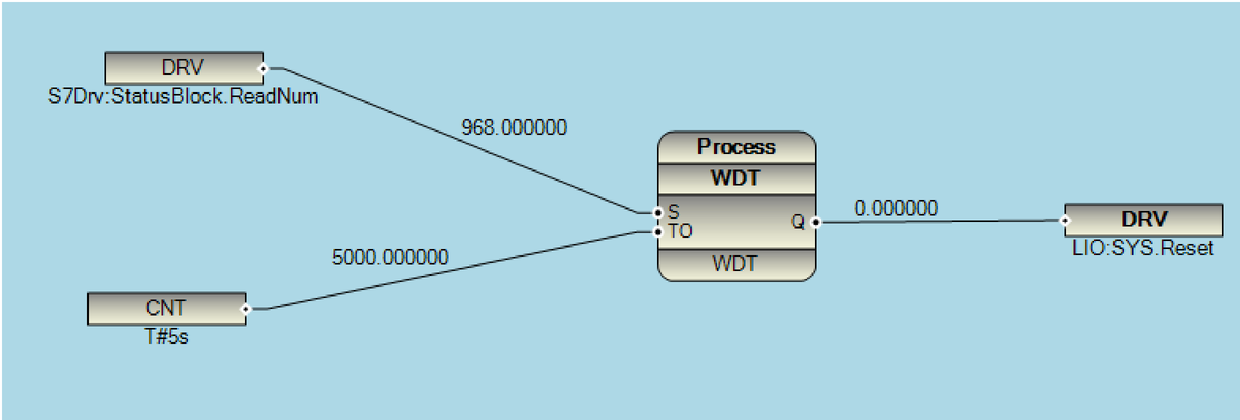
DBNum = Not used for POR, POW Blocks.

Start = Start Address of Memory area

Channels: Number of Bytes to Write/Read

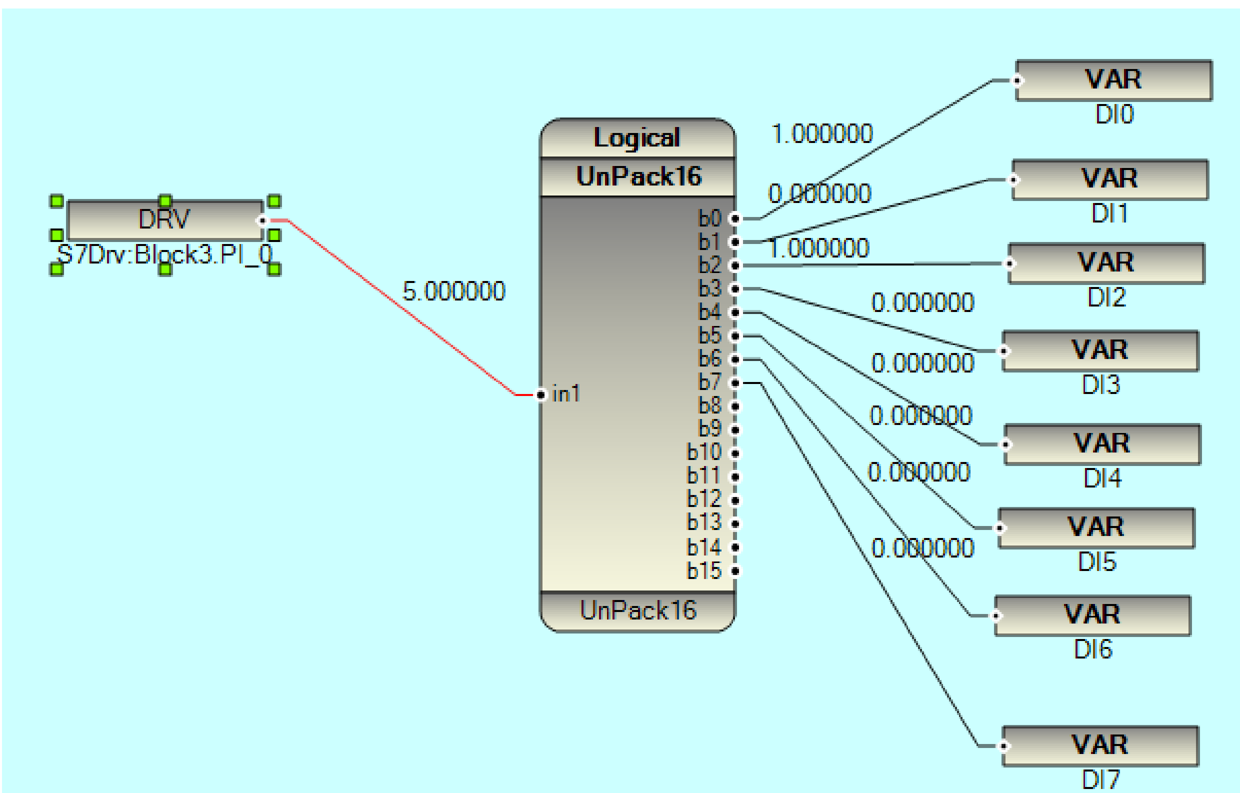
In above example RTU is reading Memory area of PLC from address 0 for 8 bytes by Block6 and will write on same area by Block7.

pbsSoftLogic is used Snap7 project for communication with S7PLC . Please refer to http://snap7.sourceforge.net/

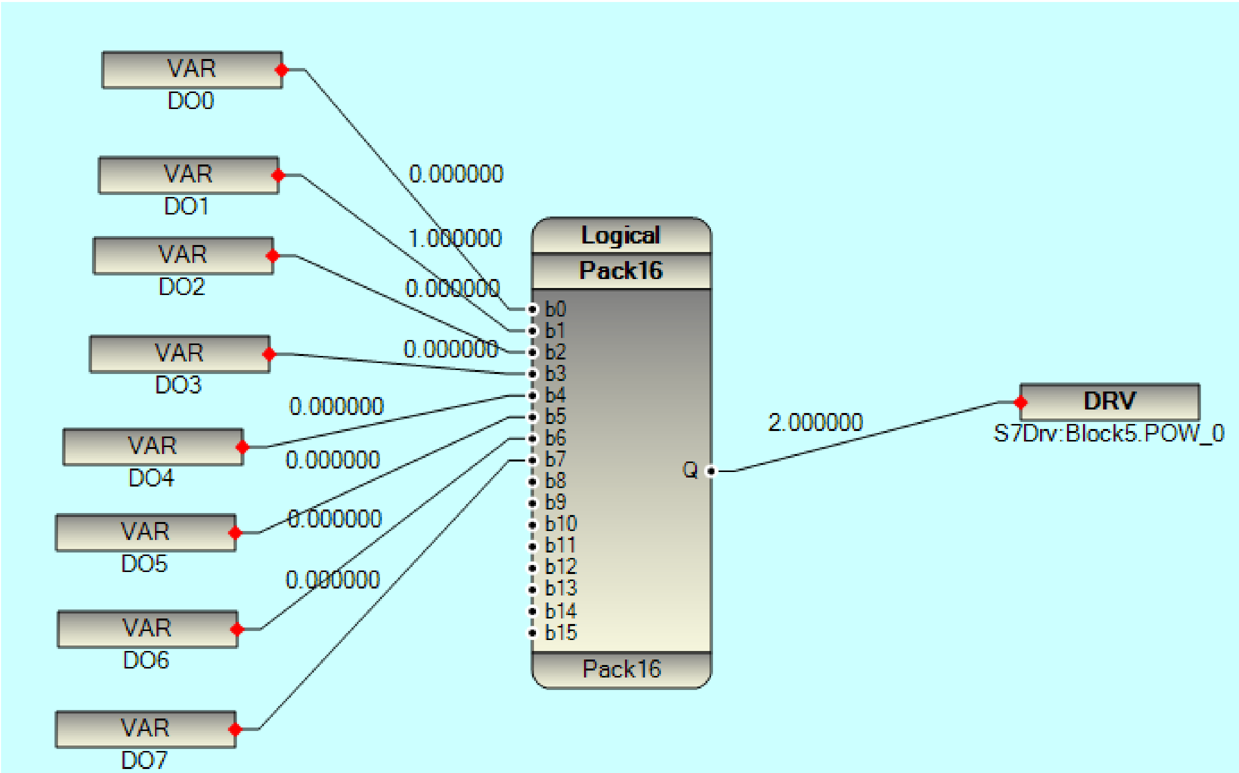


In above example RTU is checking PLC Connection status by watching ReadNum parameter. WDT function (in Process Group) it will watch S input, if S is changing in less than TO Sec, It will keep Q to 0 . But if S is not changed in TO sec, Q will change to 1.

In About Example WDT.Q Output is connected to RTU Reset Signal. It means that if RTU couldn't read Data from PLC in 5 Sec, RTU will restart Automatic for a new PLC connection.



In above example One byte of PI Block is converted to 8 Digital Input Signal (Internal Variable = VAR) to be used in Logic.

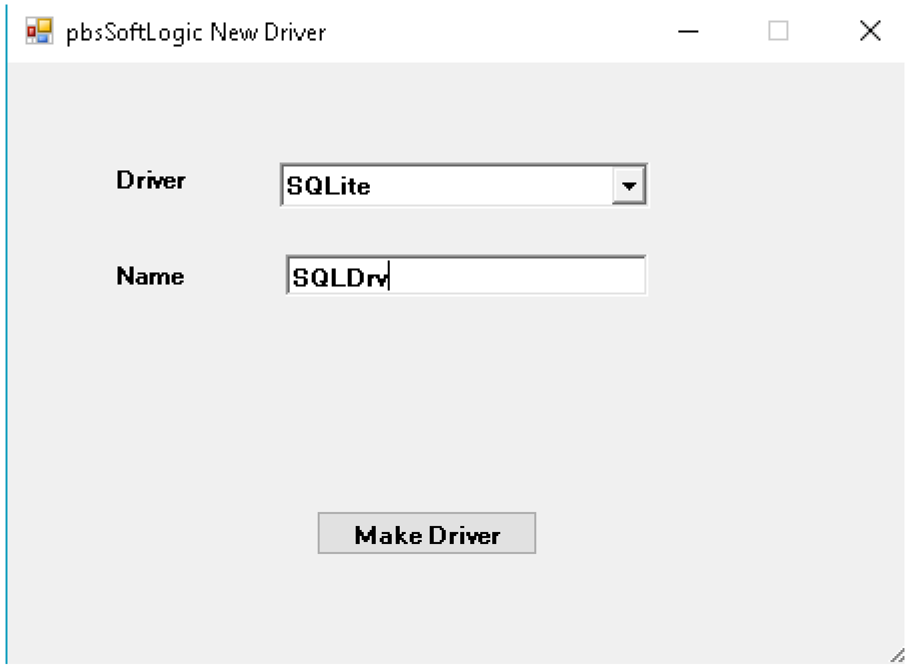


In above example 8 Internal Variable (DO0 to Do 7) is packed as one byte and written to POW_0 byte.

18 – SQLite Configuration, RTU local data Archiving and Automatic synchronization with MS SQL Server

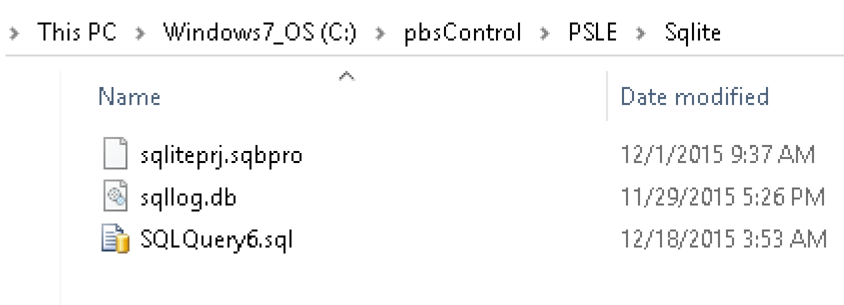
pbsSoftLogic supports SQLite Driver for RTU local data archiving . For detail information about SQLite please refer to https://www.sqlite.org/ you can synchronize SQLite in RTU with MS SQL Server in Control room automatically with help of this driver.

For adding SQLite to you project , use SQLite Driver to add to project Driver list .



You can define one instance of SQLite driver to project.

In pbsSoftLogic Directory you can see sqlite directory with following contents :



You need to transfer sqllog.db file to RTU by Filezilla. You can copy it in SD card of RTU .

For ADAM-3600 RTU External SD card path is /media/mmcblk1p1

When you make driver, pbsSoftLogic will make default configuration for you in driver directory.

options.xml
SQLiteTags.xml

Options.xml file:

```xml
<Node>
    <Name>SQLSyncUrl</Name>
    <Desc>Web Service Path in Master SCADA  for synchronization of Sqlite and  RDBMS in Master SCADA</Desc>
    <Value />
</Node>
<Node>
    <Name>RTUName</Name>
    <Desc>UniqueRTUName</Desc>
    <Value>RTU1</Value>
</Node>
<Node>
    <Name>OfflinePath</Name>
    <Desc>Save Data in this path when couldnt syncronized with master SCADA </Desc>
    <Value>/home/sqlsynclog/</Value>
</Node>
<Node>
    <Name>OfflinePath2</Name>
    <Desc>Save Data in this path when couldnt syncronized with master SCADA2 </Desc>
    <Value>/home/sqlsynclog2/</Value>
</Node>
<Node>
    <Name>LogCyclicAtMin</Name>
    <Desc>Log Data exactly at each 1 Min</Desc>
    <Value>1</Value>
</Node>
<Node>
    <Name>LogChanges</Name>
    <Desc>Log Signal when its value changes</Desc>
    <Value>0</Value>
</Node>
<Node>
    <Name>SQLDatabase</Name>
    <Desc>Path and Name of SQLite Database</Desc>
    <Value>/home/sqldb/sqllog.db</Value>
</Node>
```

```xml
<Node>
    <Name>SQLServerName</Name>
    <Desc>Name or IP address of SQL server in master scada for direct insertion of data </Desc>
    <Value>192.168.1.100</Value>
</Node>
<Node>
    <Name>SQLServerName2</Name>
    <Desc>Name or IP address of Second SQL server in master scada2 for direct insertion of data </Desc>
    <Value>192.168.1.101</Value>
</Node>
<Node>
    <Name>SQLServerUser</Name>
    <Desc>User Name for SQL Server  in master scada for direct insertion of data </Desc>
    <Value>sqlite</Value>
</Node>
<Node>
    <Name>SQLServerPassword</Name>
    <Desc>Password for SQL Server  in master scada for direct insertion of data </Desc>
    <Value>psle</Value>
</Node>
<Node>
    <Name>SQLServerDBName</Name>
    <Desc>Database Name in  SQL Server  in master scada for direct insertion of data </Desc>
    <Value>pbsHMI</Value>
</Node>
<Node>
    <Name>SQLiteRTULogEnable</Name>
    <Desc>1 = Data Will log to SQLite File inside RTU , 0 = Data is not log to SQLite inside RTU and only will send data to Master SCADA </Desc>
    <Value>1</Value>
</Node>
```

SQLSyncUrl : you can synchronize data by Master SCADA Database by two solution :

- Using Web Service to use any type of DBMS in Control room
- Direct Synchronization with MS SQL Server

When SQLSyncUrl is blank , Web service Method is disabled .

RTUName : Each RTU in the Network should has unique Name for archiving data in control room . RTU name is also used to archive data in Control Room Database directly in pbsHMI database format.

When you are using pbsHMI in Control room , each tag has a prefix in pbsHMI . Suppose your tag name in RTU is Tag1 and in pbsHMI with modbus TCP driver its name is ModbusTags.Device1.Tag1 . Then you need to use ModbusTags.Device1 as RTUName option . When SQLite driver is sending data to Control room , it will use {RTUName}+"."+{TagName } as signal name . So pbsHMi can easily use data that is send by SQLite driver for backfilling and reporting . It is not affect Instant data value in pbsHMI because SQLite Driver is directly archive data in Database of pbsHMI .

OfflinePath : when RTU is offline and there is no communication with master SCADA to synchronize data between RTU and SQL Server in Control room , RTU will archive Data in this Path . To be sure that Path is exist in RTU . Suppose you will set this path to /home/data then data directory must be in home directory for proper operation of driver.

OfflinePath2 : SQLite driver can send data to two master SCADA in the same time . This Path is for second Control room. Operation is same as OfflinePath

LogCyclicAtMin : Will log data exactly at every LogCyclicAtMin . Suppose you set this value to 5 then SQLite driver will log data at xx:00 , xx:05 , xx:10 , xx:15,xx:20,xx:25,xx:30,xx:35,xx:40,xx:45,xx:50,xx:55,…

This data logging is not related to RTU is offline with master SCADA or it is online.

SQLDatabase : full path of sqlite database . Like /media/mmcblk1p1/sqllog.db

Logchanges : not used .

SQLServerName : IP address of SQL Server in Control room .

SQLServerName2 : IP address of second SQL Server in Control room . If blank disable.

SQLServerUser : User name of MS SQL server in control room .

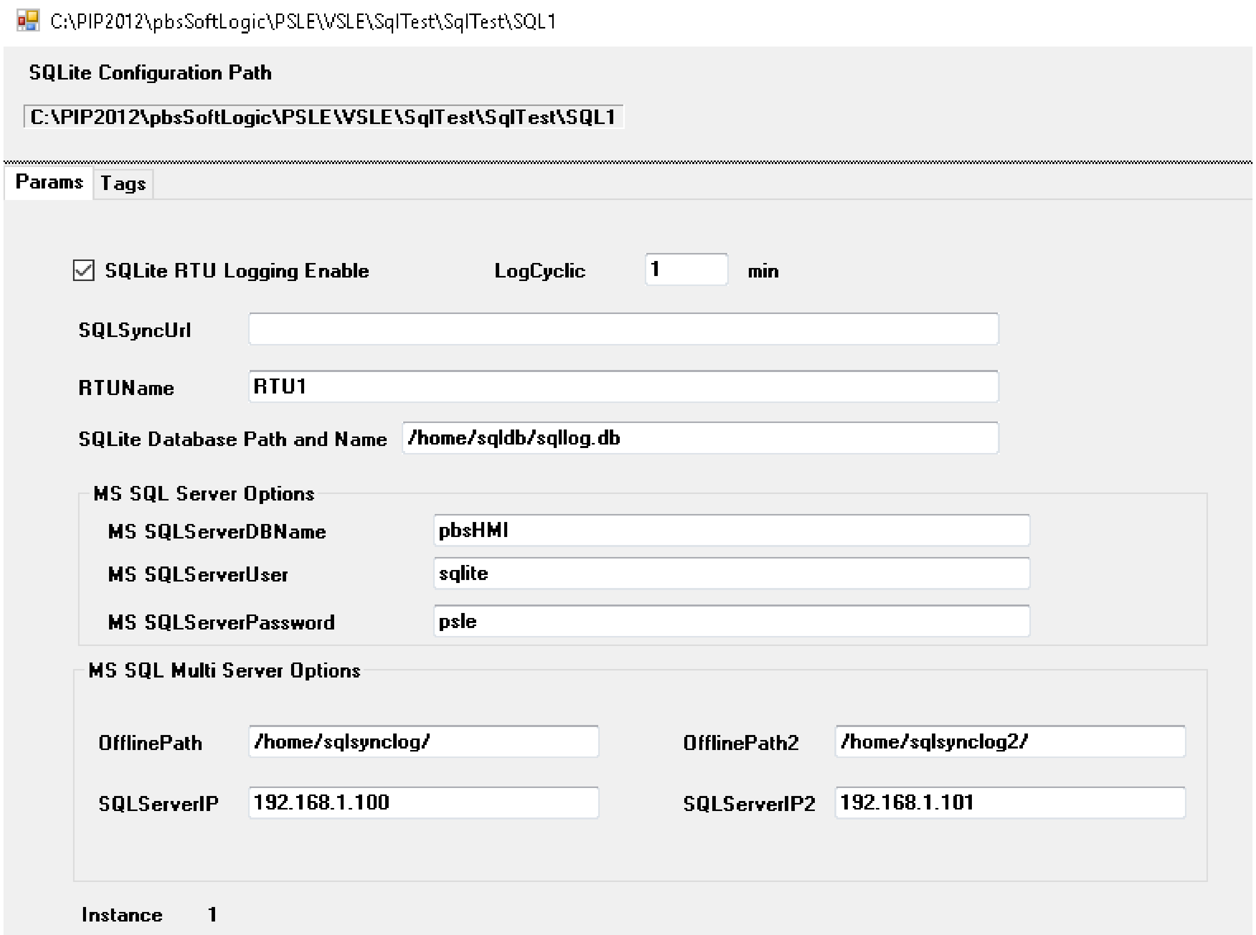
SQLServerPassword: Password of MS SQL server in control room.

Please notice that If you are using two MS SQL Server to synchronize data , both should has same user name and password for proper operation of SQLite driver .

SQLServerDBName : Database name in SQL Server . you need to use pbsHMI database in control room .

SQLiteRTULogEnable : if set to 1 , Data will archive in RTU in SQLite format . If set to 0 , Data is only send to SQL Server in Control room and SQLite is not used in RTU . But Backfilling is working without problem in this Mode.

You can use pbsSoftLogic SQLite Editor to set all above parameters . for using SQLite Editor , in Driver List , Right Click and select Edit .

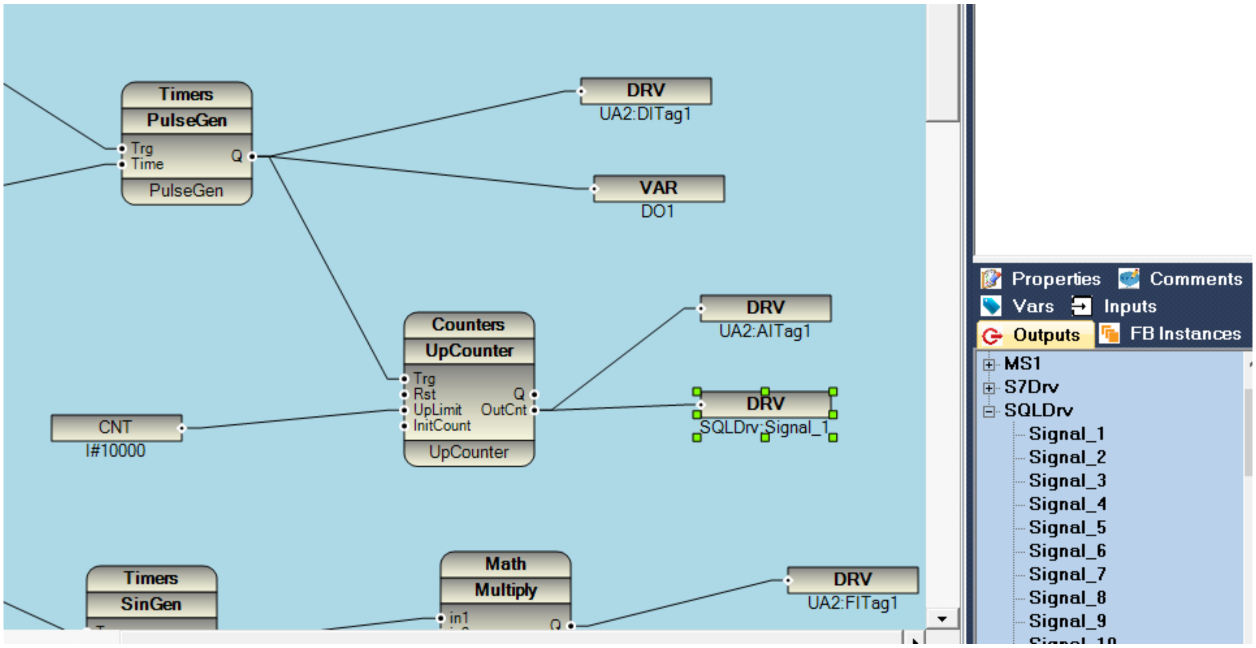


For saving configuration , right click on any point in SQLite Editor form and select Save menu .

SQLiteTags.xml: you can define Tags in this file. Only you need to define tag name. You can define maximum 1024 Tags for SQlite Driver.

```xml
<OPCSrvTags>
    <Version>1.0.0</Version>
    <Tag Name="Signal_1" />
    <Tag Name="Signal_2" />
    <Tag Name="Signal_3" />
    <Tag Name="Signal_4" />
    <Tag Name="Signal_5" />
    <Tag Name="Signal_6" />
    <Tag Name="Signal_7" />
    <Tag Name="Signal_8" />
    <Tag Name="Signal_9" />
    <Tag Name="Signal_10" />
    <Tag Name="Signal_11" />
    <Tag Name="Signal_12" />
    <Tag Name="Signal_13" />
    <Tag Name="Signal_14" />
    <Tag Name="Signal_15" />
    <Tag Name="Signal_16" />
    <Tag Name="Signal_17" />
    <Tag Name="Signal_18" />
    <Tag Name="Signal_19" />
    <Tag Name="Signal_20" />
    <Tag Name="Signal_21" />
    <Tag Name="Signal_22" />
    <Tag Name="Signal_23" />
    <Tag Name="Signal_24" />
    <Tag Name="Signal_25" />
    <Tag Name="Signal_26" />
    <Tag Name="Signal_27" />
    <Tag Name="Signal_28" />
    <Tag Name="Signal_29" />
    <Tag Name="Signal_30" />
    <Tag Name="Signal_31" />
    <Tag Name="Signal_32" />
</OPCSrvTags>
```

You should write all above signals in your logic. Like following sample:



At each cycle, logic will write Sqlite Signals value to Driver. Driver has internal memory for save all SQLite signals. When it is time for logging, driver will read all internal memory and save them on the SQLite database with current time value for all signals. SQlite driver is not buffering all signal changes and only will save signals vale at logging time.

There are many free SQLite browser and management utility in the market.

You can use following as sample:

SQLite DB Browser : http://sqlitebrowser.org/

SQLite Studio : http://sqlitestudio.pl/

SQLite Expert : http://www.sqliteexpert.com/

Database structure:

Sqllog.db has two main tables:

- TagIndex
- TagData

TagIndex Table Fields:

Index	Name	Declared Type	Type	Size	Precision	Not Null
1	ID	INTEGER	INTEGER	0	0	☑
2	TagName	TEXT	TEXT	0	0	☑

TagData Table Fields:

Index	Name	Declared Type	Type	Size	Precision	Not Null
1	ID	INTEGER	INTEGER	0	0	☑
2	TagDT	NUMERIC	NUMERIC	0	0	☑
3	TagValue	REAL	REAL	0	0	☑

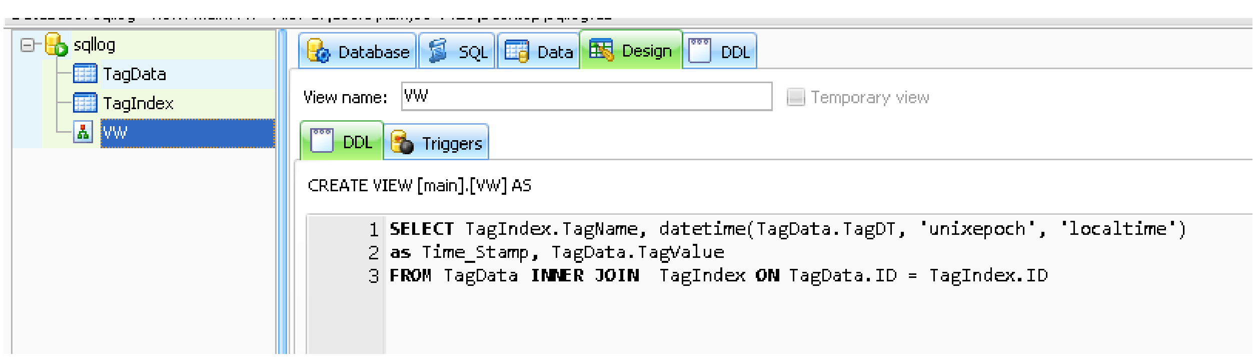
When Driver wants to insert one record to database , it will do following tasks :

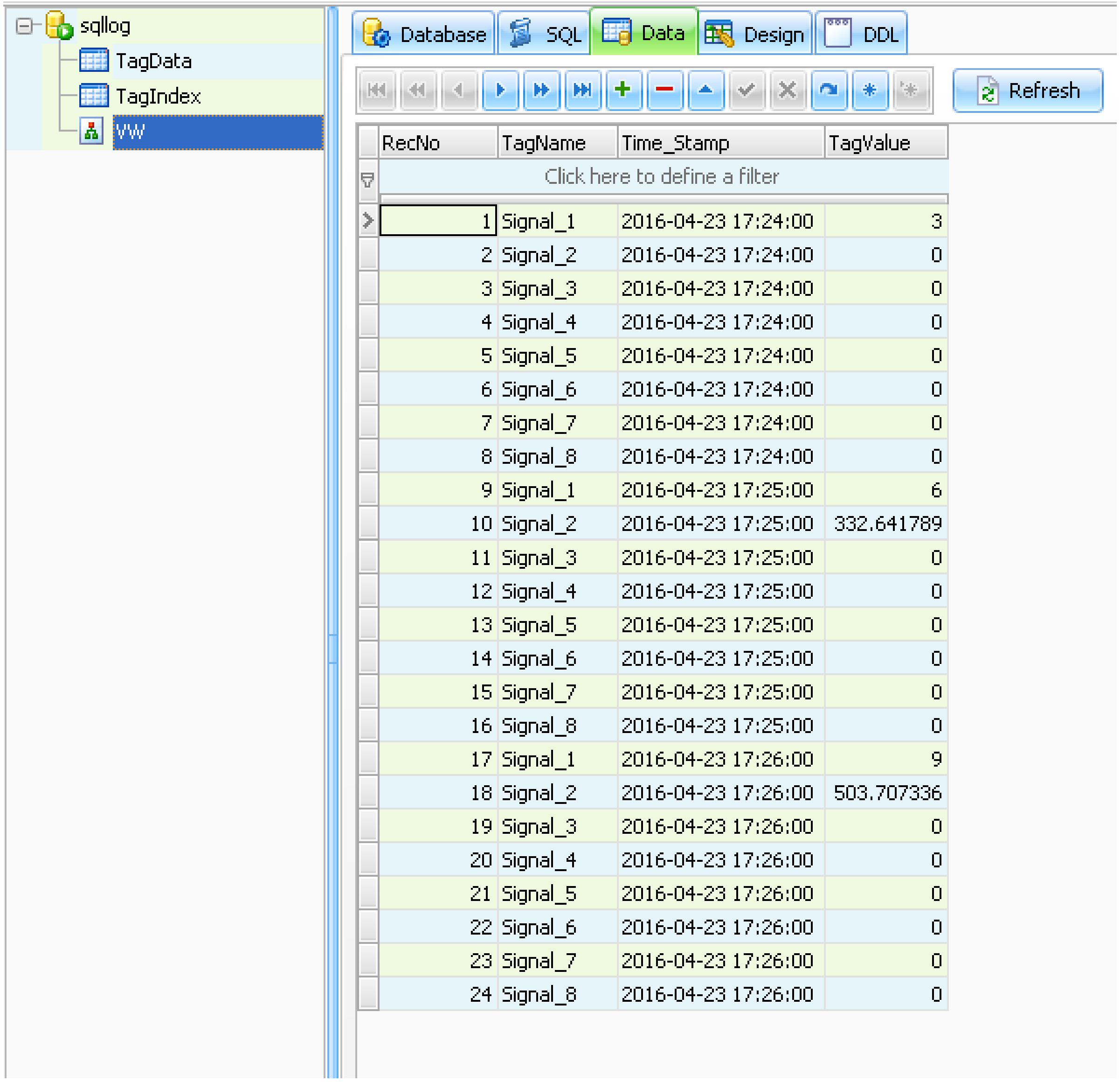
- Check in TagIndex Table , if Tag name is Inserted before it will get Tag ID
- If Tag Name is not inserted into TagIndex , It will insert TagName and will get new TagID
- With TagID , TagValue and TagDT(Data Time) , Driver will insert one record into TagData Table

In other words, TagIndex is Definition of tags (record number is equal to Number of Tags) and TagData is real data archiving in database. TagData will increase based on number of Records in the database.

TagDT is Elapsed Time which is seconds from 1/1/1970.

You can use following view to see readable view from database: (VW view is already in the sqllog.db)



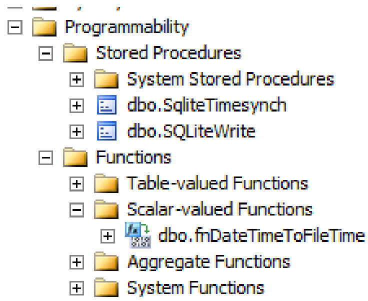


RecNo	TagName	Time_Stamp	TagValue
1	Signal_1	2016-04-23 17:24:00	3
2	Signal_2	2016-04-23 17:24:00	0
3	Signal_3	2016-04-23 17:24:00	0
4	Signal_4	2016-04-23 17:24:00	0
5	Signal_5	2016-04-23 17:24:00	0
6	Signal_6	2016-04-23 17:24:00	0
7	Signal_7	2016-04-23 17:24:00	0
8	Signal_8	2016-04-23 17:24:00	0
9	Signal_1	2016-04-23 17:25:00	6
10	Signal_2	2016-04-23 17:25:00	332.641789
11	Signal_3	2016-04-23 17:25:00	0
12	Signal_4	2016-04-23 17:25:00	0
13	Signal_5	2016-04-23 17:25:00	0
14	Signal_6	2016-04-23 17:25:00	0
15	Signal_7	2016-04-23 17:25:00	0
16	Signal_8	2016-04-23 17:25:00	0
17	Signal_1	2016-04-23 17:26:00	9
18	Signal_2	2016-04-23 17:26:00	503.707336
19	Signal_3	2016-04-23 17:26:00	0
20	Signal_4	2016-04-23 17:26:00	0
21	Signal_5	2016-04-23 17:26:00	0
22	Signal_6	2016-04-23 17:26:00	0
23	Signal_7	2016-04-23 17:26:00	0
24	Signal_8	2016-04-23 17:26:00	0

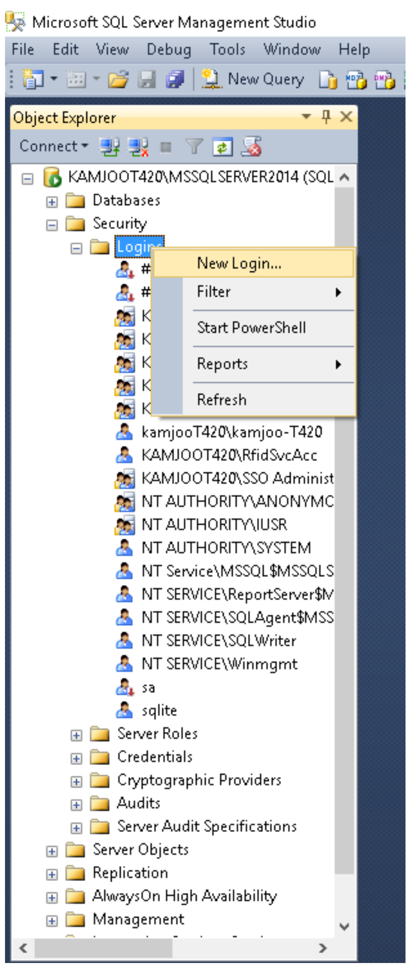
You can easily transfer sqllog.db to your server in control room and open it by any SQLite browser and analysis stored data.

MS SQL Server setting : you need to define pbsHMI Database in SQL Server at control room and define one User with password to use in SQLite Driver . Please do following steps :

1- Make a new database in SQL Server ,name it pbsHMI.
2- Use SQL Script that is in SQLite Directory of pbsSoftLogic or use Database directory of pbsHMI
3- Run SQLServerData.sql and SQLServerIndex.sql to make data and index tables in pbsHMI Databse
4- Run fnDateTimeToFileTime.sql , SqliteTimesynch.sql and SQLiteWrite.sql to make all necessary Stored procure and Scalar functions in pbsHMI Database

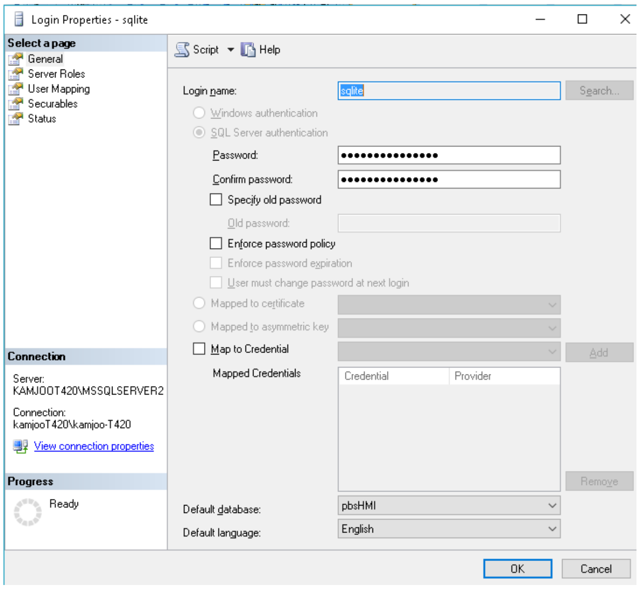


5- In SQl Server Management studio , Use “Security” item and open “Login” segment .
6- Right click in Login and select New Login

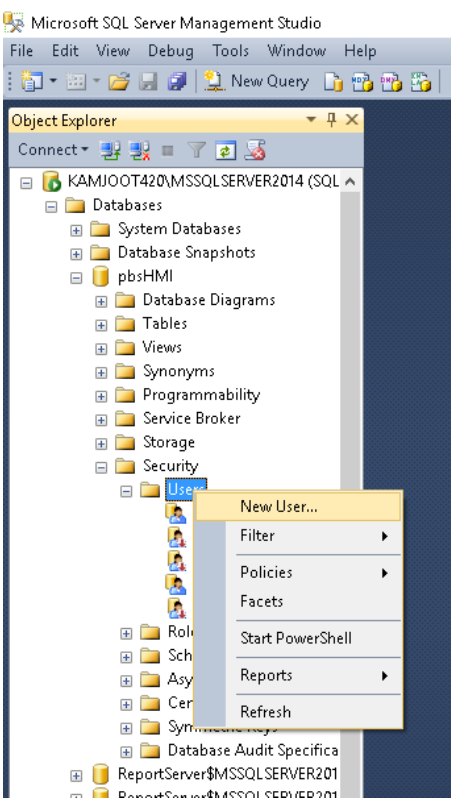


6 – In Login Properties page type user name for example “sqlite” and set password .Remove pass policy , expiration and user should change password in next login . you will use this user and password in SQLite driver options .

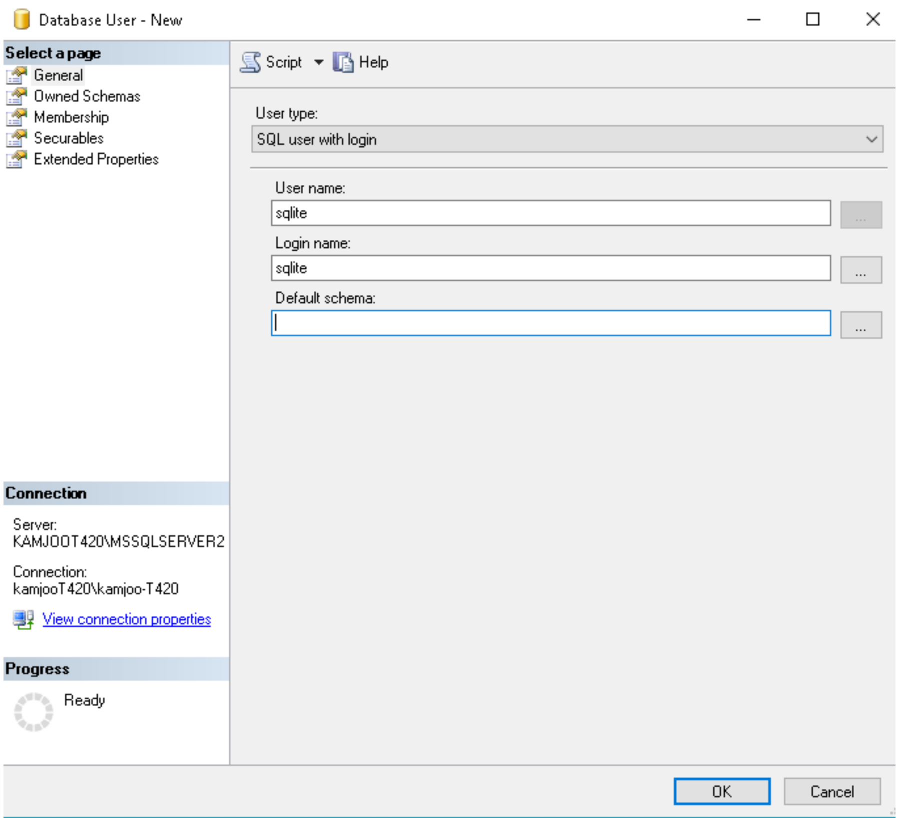
7 – select pbsHMI as default database .



8 – select pbsHMI Database , Select Security and open Users and right click on user to make new user.

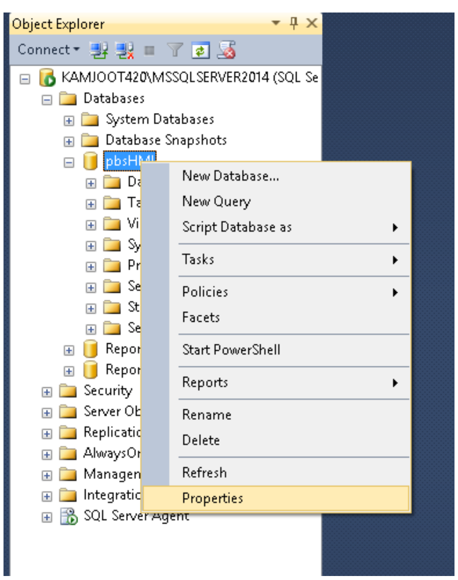


9 –use same user that you make for SQL server “sqlite” and redefine it here.

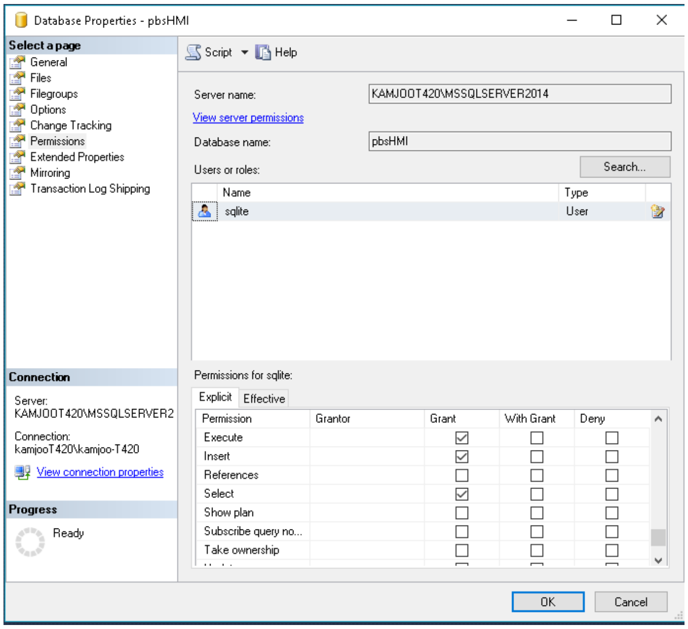


10 – Click on ok to define user .

11 – Select properties of pbsHMI Database

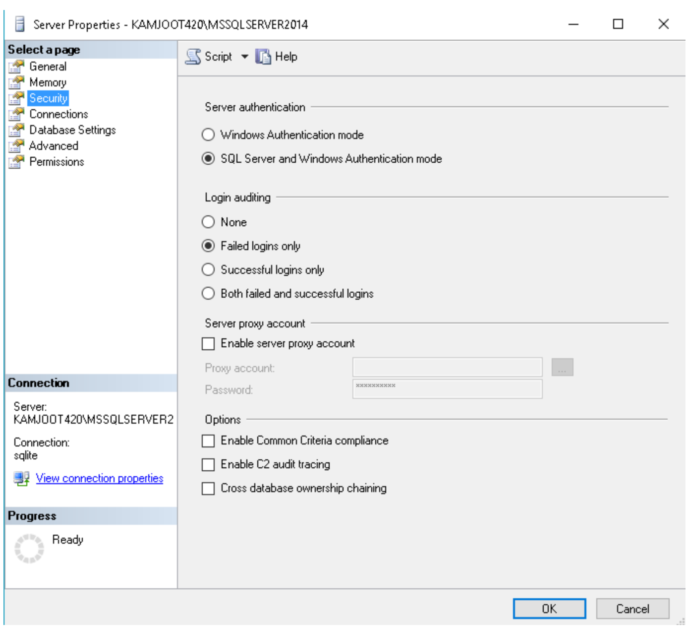


12 – select permissions Page and Grant Connect , Execute , Insert , Update , Delete and select functionality to sqlite user . In this stage SQL Server is ready for proper operation with SQLite driver .



13 – To be sure pbsHMI Database collation is not Arabic , Persian , … and only Latin like SQL_Latin1_General_CP1_CI_AS will communicate with RTU

14 – To be Sure SQL Server Authentication is SQL Server and Windows

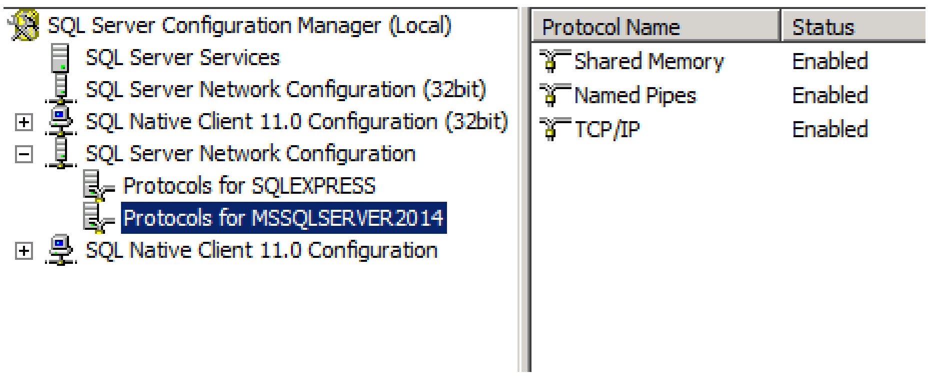


15 – Check in Windows Firewall. TCP Port 1433 should be allowed in both inbound and outbound rules.

16 – Check in Windows Firewall. SQLBrowser.exe utility should be in Allowed programs List .you can find SQLBrowser.exe Path from C:\Program Files (x86)\Microsoft SQL Server\90\Shared\sqlbrowser.exe

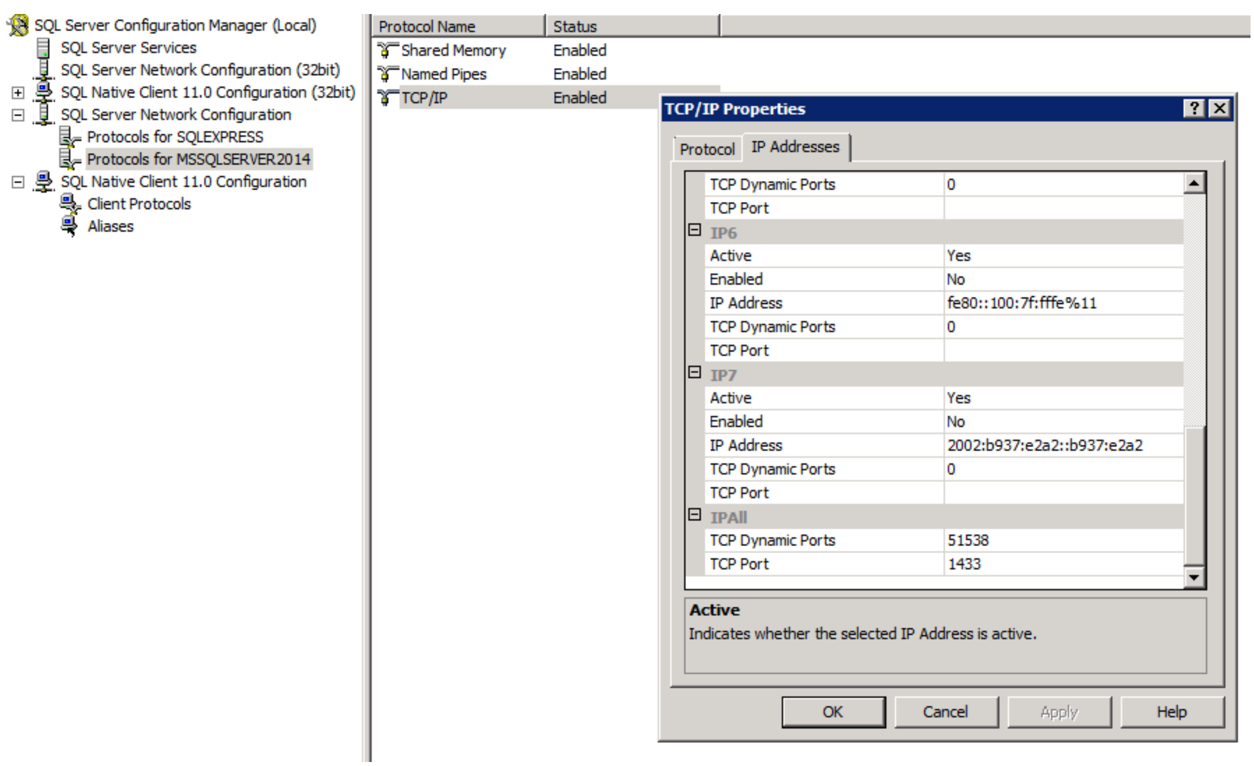
To be sure SQL Server and SQL Server Browser Services are started properly.

17 – Open SQL Server Configuration Utility and open SQLServer Network Configuration.



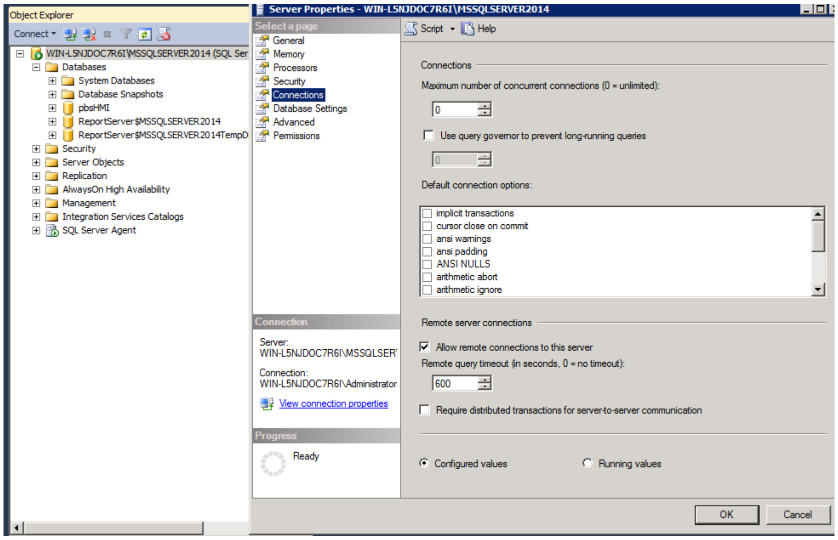
To be sure Named Pipes and TCP/IP protocols are enabled. You can Make Them Enable by Right Click on each Item and select Enable Option.

Double click on TCP/IP Protocol and select IP Tab.



Scroll Down to IPALL and write TCP Port 1433.

18 – Open property page of main SQL server instance and select Connections.



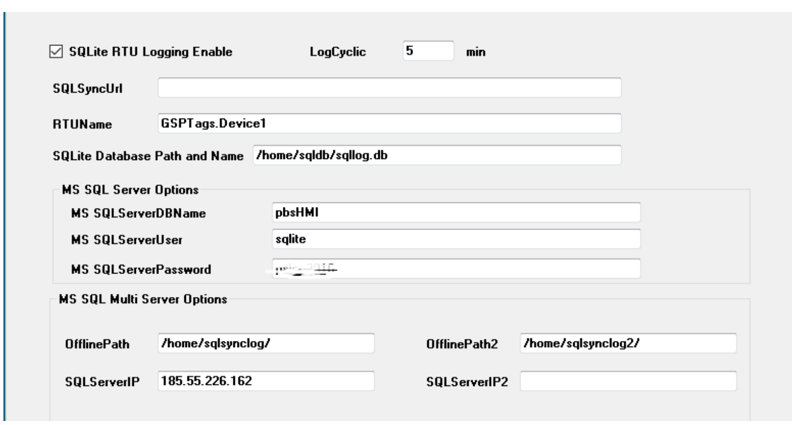
To be sure Allow Remote Connections to this server is checked.

19 – Restart SQL Server Service.

20 – In RTU edit /etc/freetds/freetds.conf file and find global part setting and do following changes :

```
# Global settings are overridden by those in a database
# server specific section
[global]
        # TDS protocol version
        port = 1433
        tds version = 7.0
```

20 – To be sure that Offline Path, Offline Path2 and SQLite Database are existing inside RTU.



SQLite Driver with SQL Server Automatic synchronization is only work on pbs2008RTU , pbs2010GW ,pbs2012GW , ADAM-3600 and UNO1252G .

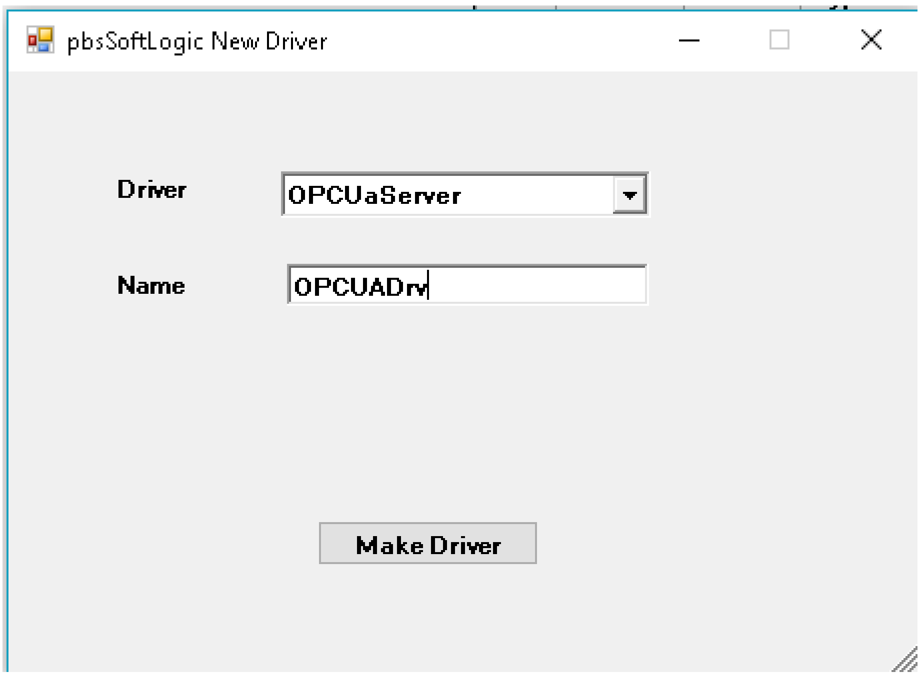
19 – OPC UA Server configuration for RTU.

pbsSoftLogic is supporting OPC UA Server functionality for ADAM-3600 and pbs2008RTU .

pbsSoftLogic is using OpenOPCUa (http://www.openopcua.org) technology for implementing OPC UA functionality .

For detail information about OPC-UA please refer to www.opcfoundation.org

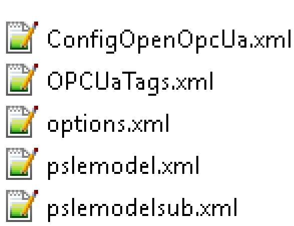
For adding OPC UA Server driver to your project from new driver list page, select OPCUaServer Driver:



Select a unique name for your driver. You can only define one OPC UA Driver for a project.

Click on Make Driver button, pbsSoftLogic will make default configuration in driver directory.

In Driver directory you can see following files:



You need to do configuration for options.xml and OPCUaTags.xml files. Other files are systematic and generated by pbsSoftLogic when you save project settings.

OpenOPCUaCore Server should install on your RTU and running automatic at boot time for proper operation of OPC UA Driver.

Options.xml file :

```
<Options>
	<Version>1.0.0</Version>
	<Node>
		<Name>TCPPort</Name>
		<Desc>TCPPort</Desc>
		<Value>4840</Value>
	</Node>
	<Node>
		<Name>Instance</Name>
		<Desc>Instance</Desc>
		<Value>1</Value>
	</Node>
</Options>
```

TCPPort = you need to assign not used TCP port for OPC UA Communication. OPCOpcUa System is using TCP for communication in physical layer. The IANA registered port for "OPC UA /TCP" is 4840.

OPCUaTags.xml file

OPCUA Tags are defined in this file. In following sample file you can see different tag types. You can define maximum 1024 OPC UA Tags.

There are following Tag Types:

DI = Digital input = Boolean (Read by Client)

DO = Digital Output = Boolean (Read/Write by Client)

AI = Analog Input (2 Bytes Signed - Read by Client)

UAI = unsigned Analog Input (2 Bytes unsigned - Read by Client)

AO = Analog Output (2 Bytes Signed – Read/Write by Client)

FI = Float Input (4 Bytes Signed - Read by Client)

FO = Float Output (4 Bytes Signed – Read/Write by Client)

LI = Long Input (4 Bytes Signed - Read by Client)

ULI = unsigned Long Input (4 Bytes unsigned - Read by Client)

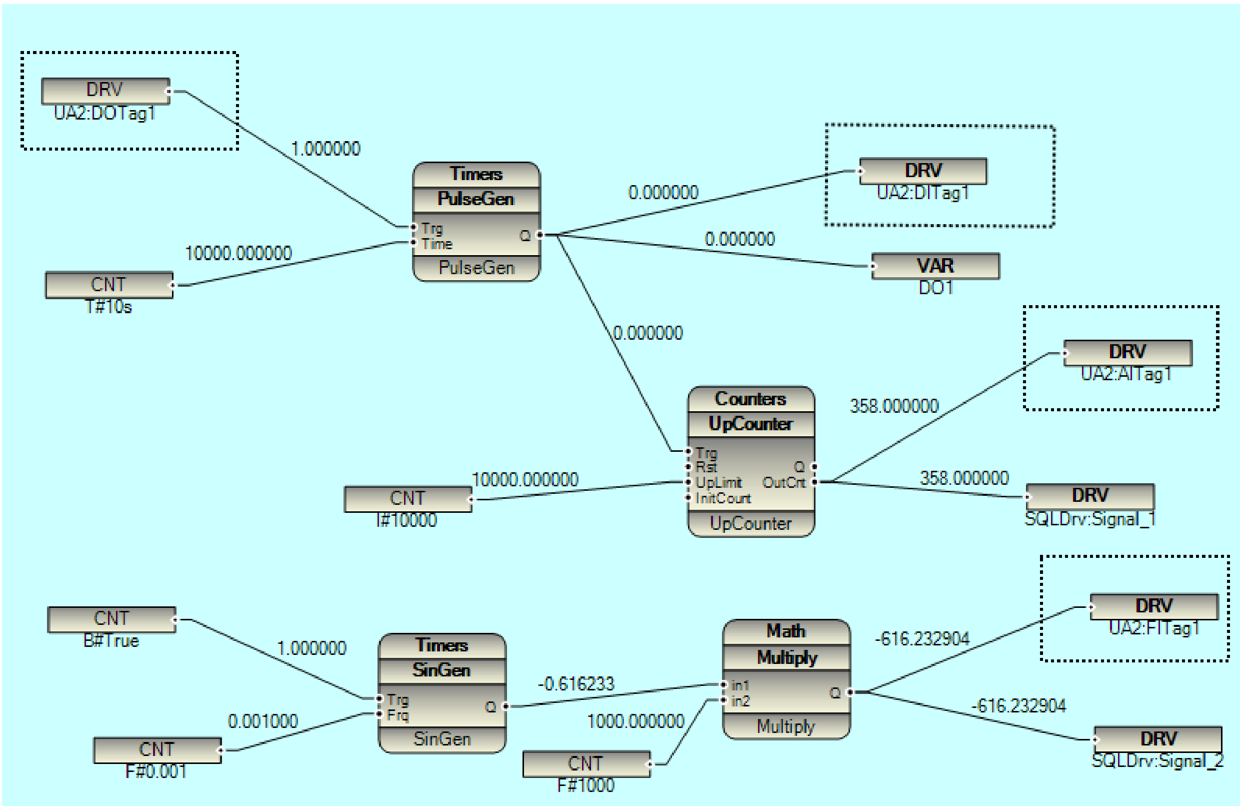
DBI = Double Input (8 Bytes Signed - Read by Client)

DBO = Double Output (8 Bytes Signed – Read/Write by Client)

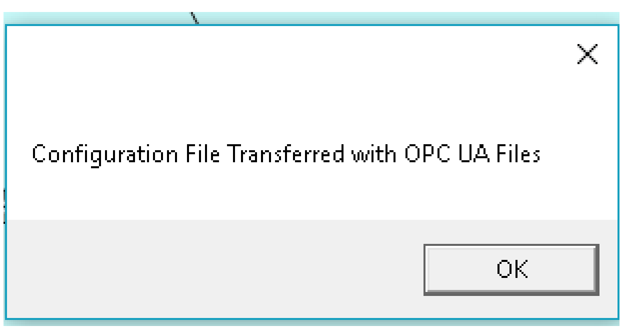
```
<OPCSrvTags>
    <Version>1.0.0</Version>
    <Tag Name="DITag1" Type="DI" Init="False" />
    <Tag Name="DITag2" Type="DI" Init="False" />

    <Tag Name="DOTag1" Type="DO" Init="False" />
    <Tag Name="DOTag2" Type="DO" Init="False" />

    <Tag Name="AITag1" Type="AI" Init="0" />
    <Tag Name="AITag2" Type="AI" Init="0" />

    <Tag Name="UAITag1" Type="UAI" Init="0" />
    <Tag Name="UAITag2" Type="UAI" Init="0" />

    <Tag Name="AOTag1" Type="AO" Init="0" />
    <Tag Name="AOTag2" Type="AO" Init="0" />

    <Tag Name="FITag1" Type="FI" Init="0" />
    <Tag Name="FITag2" Type="FI" Init="0" />

    <Tag Name="FOTag1" Type="FO" Init="0" />
    <Tag Name="FOTag2" Type="FO" Init="0" />

    <Tag Name="LITag1" Type="LI" Init="0" />
    <Tag Name="LITag2" Type="LI" Init="0" />

    <Tag Name="ULITag1" Type="ULI" Init="0" />
    <Tag Name="ULITag2" Type="ULI" Init="0" />

    <Tag Name="DBITag1" Type="DBI" Init="0" />
    <Tag Name="DBITag2" Type="DBI" Init="0" />

    <Tag Name="DBOTag1" Type="DBO" Init="0" />
    <Tag Name="DBOTag2" Type="DBO" Init="0" />
</OPCSrvTags>
```

You need to write Input Tags (DI , AI , UAI , LI , ULI , FI ,DBI) In logic and read output Tags (DO , AO , FO , DBO)

In following sample, UA2:DOTag1 is connected to FB Input Side (Read) and UA2:DITag1, UA2:AITag1, UA2:FITag1 are connected to FB output side (Write)



When you transfer configuration to RTU, you will see following message that shows OPC UA Systematic files are also transferred to RTU.



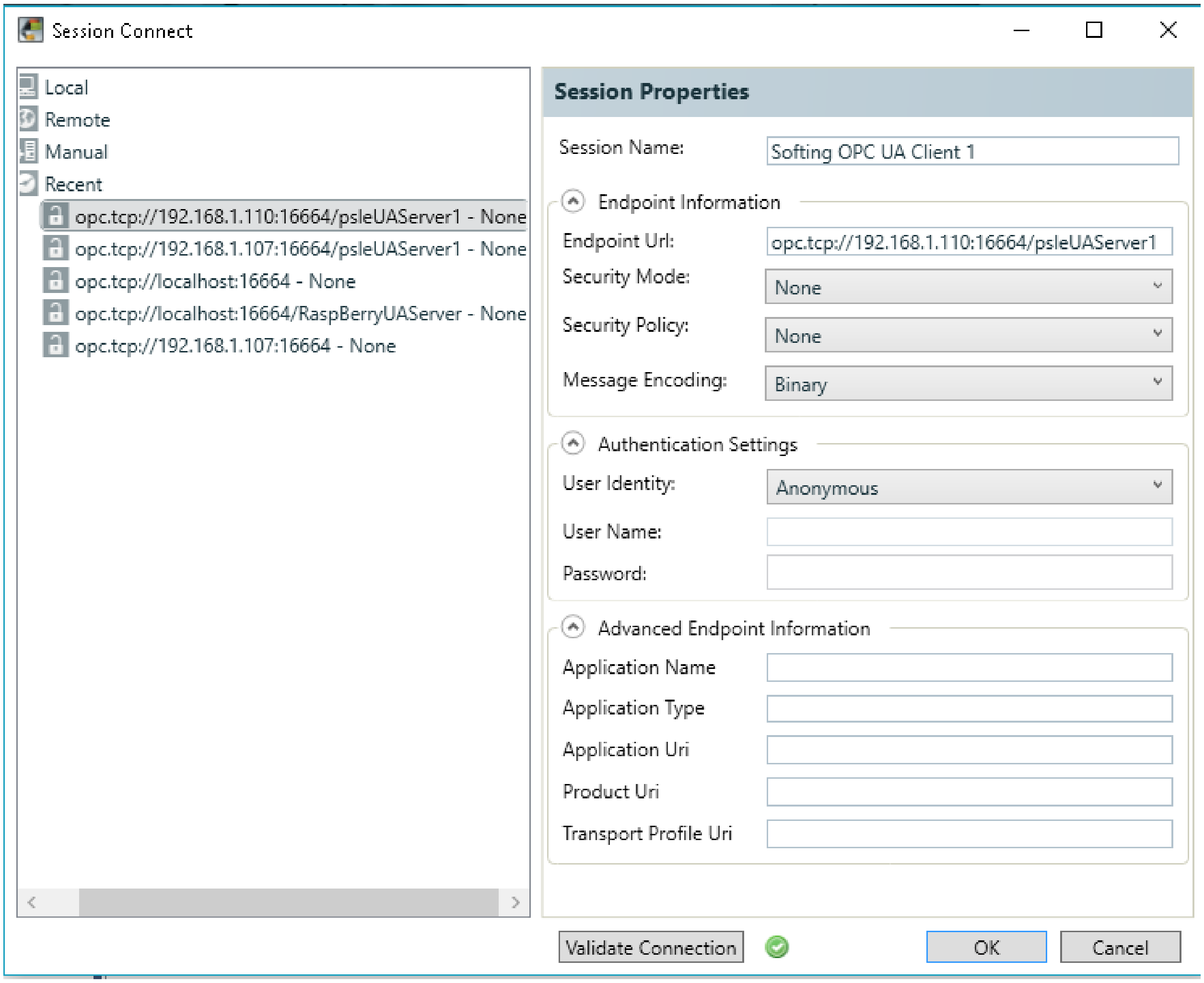
Reset RTU when you did modification in OPC UA Tags and configuration .

OPC UA Client Connection:

You can use any OPC UA Browser utility to connect to RTU by OPC UA protocol.

Softing OPC UA client: It is a free OPC UA Browser that you can download from www.softing.com

Create a new session with following parameters:



End Point URL has following format:

opc.tcp://{RTU IP address} :{ OPC UA TCP Port}/psleUAServer1

Example:

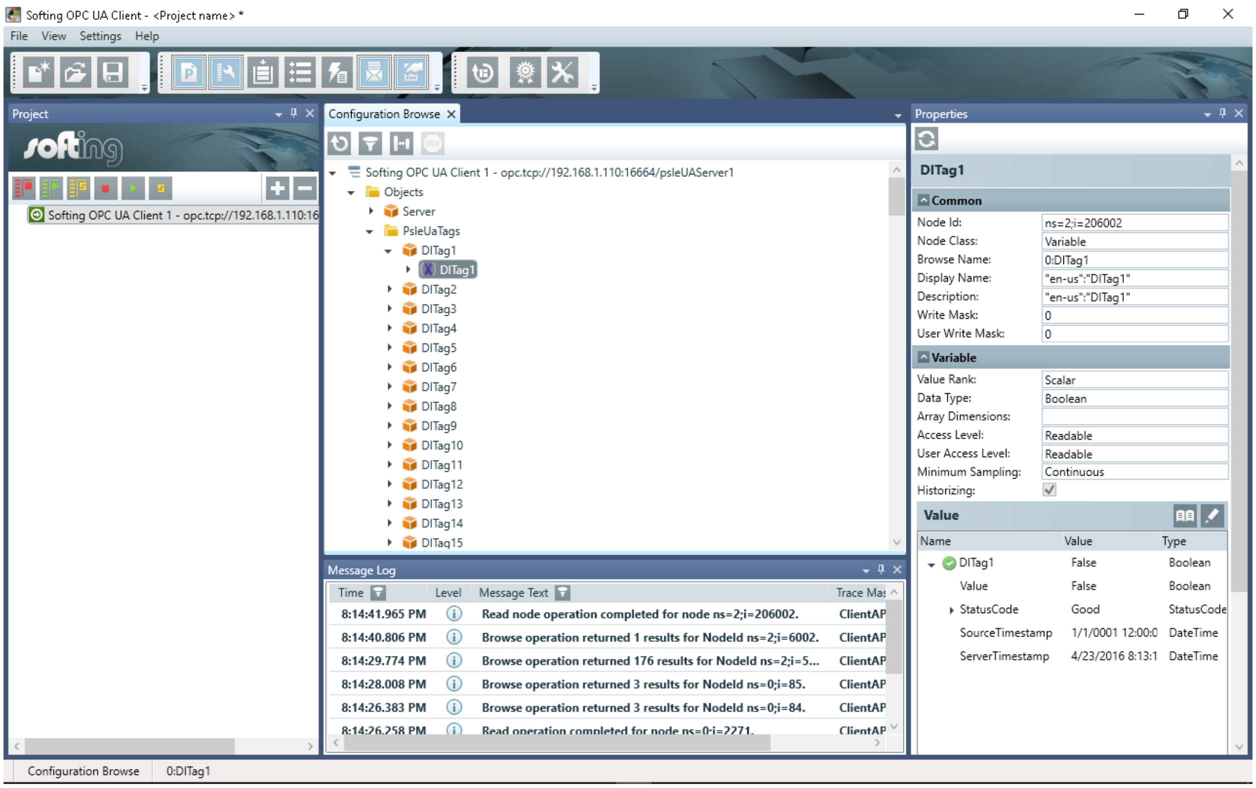
opc.tcp://192.168.1.110:16664/psleUAServer1

OPC UA supports different modes for security. OpenOPCUA supports all modes, but in pbsSoftLogic we only support Anonymous (No Security)

OPC UA TCP Port should be defined before for Network and firewall software's for proper communication between client and RTU.

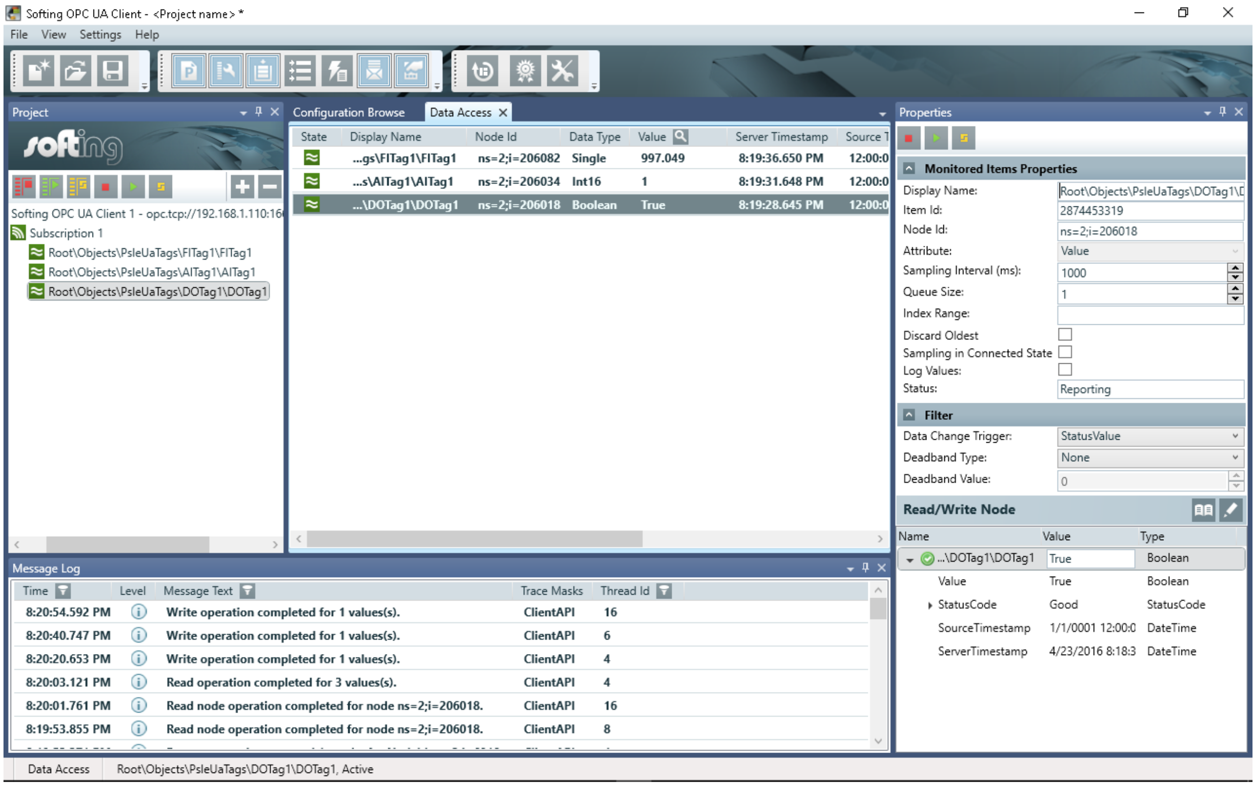
Click on Validate connection, it should be changed to green check mark for correct validation.

Click on OK Button, you should see tag Data types, Objects, as following page:



pbsSoftLogic Tags will be found in Objects\PsleUaTags folder .

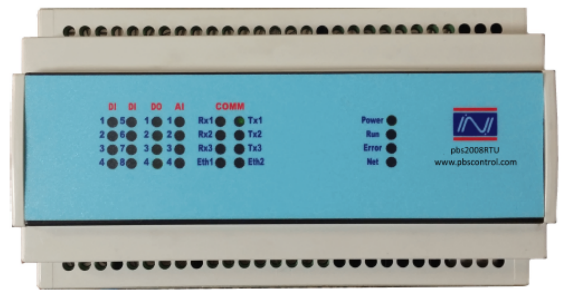
By double clicking on a tag, it will be included to subscribe tags, so you can get automatic tags changes in OPC UA Client application.



20 – pbs2008RTU Configuration

Pbs2008RTU is a common product between Alborz Micro System (AMS) and pbsControl. Hardware is manufactured by AMS and it is powered by pbsSoftLogic. Pbs2008RTU supports all pbsSoftLogic protocols.

- Low power
- Small size fully packaged RTU
- Support multiple industry standard
- Support multiple communication protocols
- Internal Integrated cellular modem (GPRS/3G)



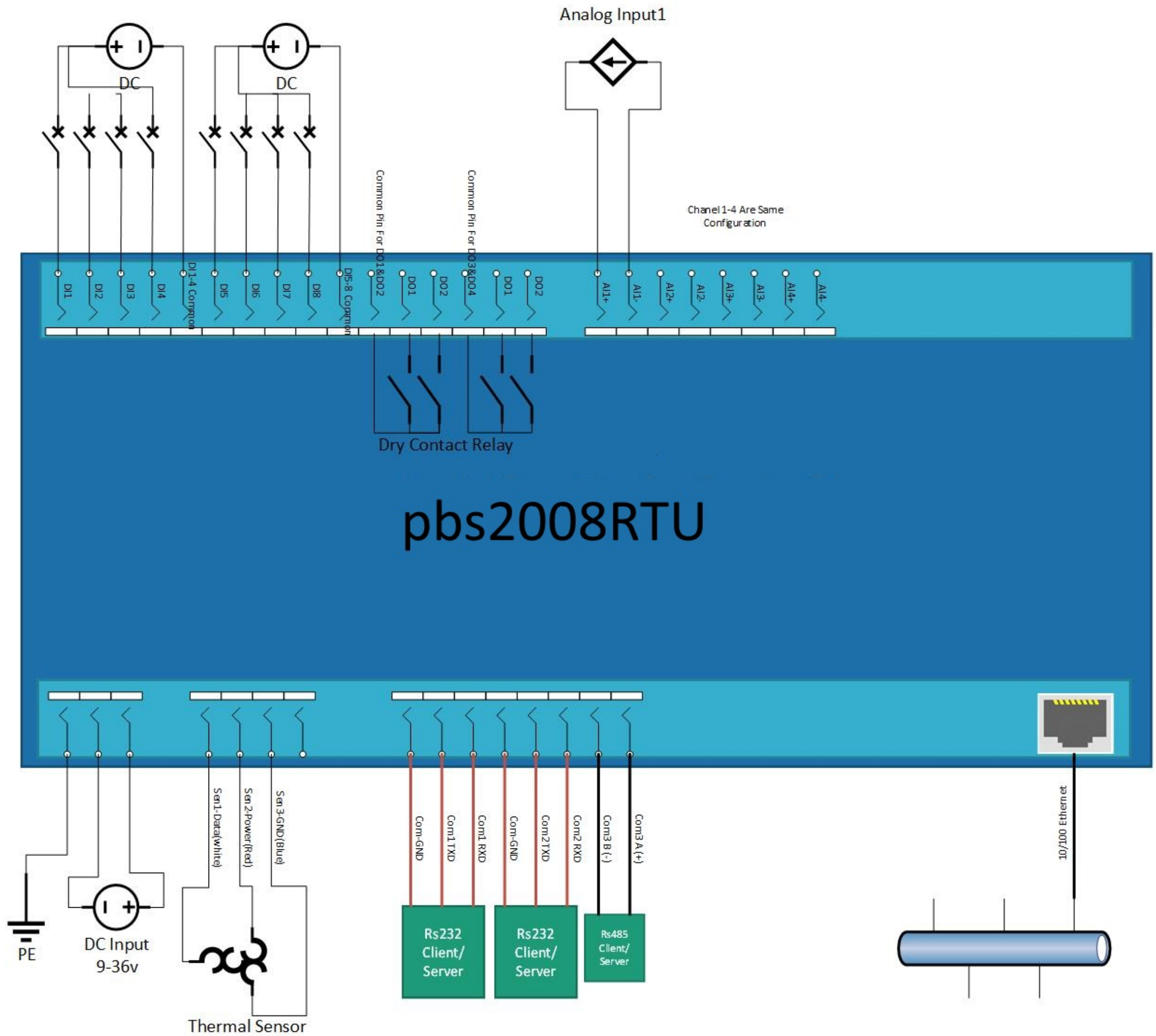
Features

- 8x digital Inputs / 4 xdigital output
- 4x analog Inputs /2x Temperature Input DS18b20
- pbsSoftLogic IEC61131 based Programming Environment (Function Block, Lua)
- All indicators, Serial Interfaces and I/O connectors are via the front of the unit allowing ease of
- access.
- Wide communication platform 2xRS232 - 1xRS485 -1x 10/100Ethernet

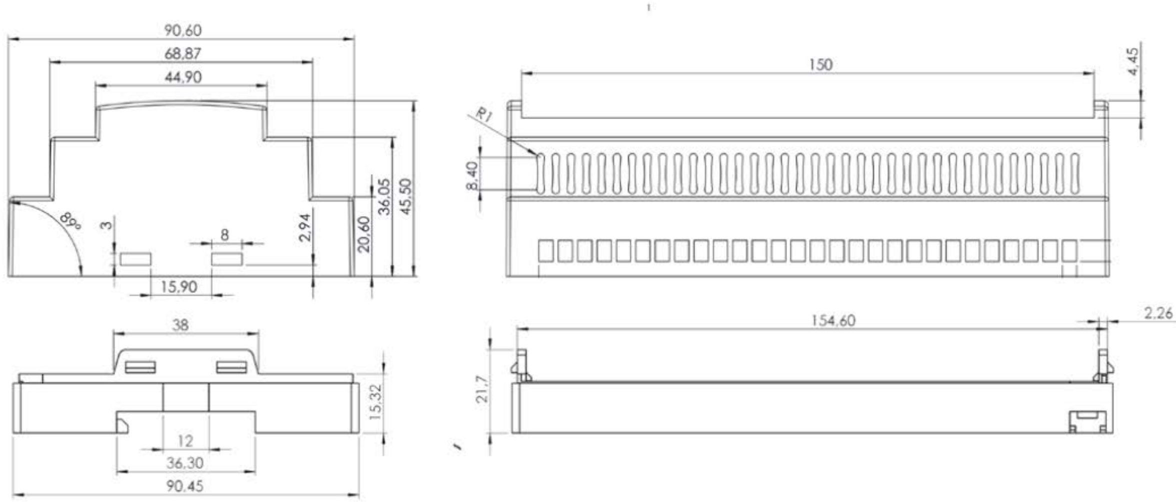
Power Supply and Consumption	External Power	+9-36 VDC
	Power Consumption	Sleep Mode : 3G Modem is off 2~2.5 W Normal Mode : 4~5 W
	Internal RTC Power	3V Coin Cell - Type 2023
I/O	Digital Input	8Ch (+12-30VDC) Isolation 2K Vrms / 3K VDC
	Digital Output	4Ch (Relay 2A ~ 250V)
	Analog Input	4Ch 12Bit (4-20mA / 0-20mA / 0-5V)
	Temperature Input	2 Ch DS18b20 (-60 to +120 c)
Communication	Internal	2x Serial RS232 (without Handshaking) 1x Serial RS485 1x 10/100 Ethernet
	Cellular Modem(GSM)	Internal WCDMA Modem (2G/3G/4G) Data SMS

CPU	CPU	32-bit ARM Cortex A8 @ 1GHz
	Memory	Flash 4GB (EMMC) RAM 512 MB DDR3 Micro SD Slot: Up to 32GB
Programming Tools	IEC61131	Function Block User defined FB by Lua Scripting
	Operating system	Embedded Linux
Real Time Clock	Internal RTC	Accuracy 5 sec in year @ 25'C

Physical	Size (WxHxD)	157.5x91x58.4 mm 6.2x3.58x2.3 inches
	Material	ABS UL-94-HB
Mounting	DIN Rail mounting	Wall Mounting Available
Environmental Parameter	Temperature	-30°C ~ 70°C
	Humidity	0 ~ 95 % non-condensing



Setting Analog Input Signals : There are two set of DIP Switches inside RTU or in back Side that are used for setting Analog input Mode on Voltage or Current . by default it is set on Current Mode (Both Switch for each channel is set to ON) for changing to Voltage , set both Switch for specific channel to OFF . In Following figure Channels 1,2,3, are set to current and channel 4 to Voltage .



System LED

LED	Color	Function Description
POWER	Green	Light on, Device powered
RUN	Blue	Blinking, Runtime Operation
ERROR	Red	Blinking, Runtime Error Light on, Exception Error
NET	Yellow	200ms On/ 1800ms Off, Network searching 1800ms On/ 200ms Off, IDLE 180ms On/ 180ms Off, Data transfer is ongoing Always On, Voice Call Always Off, Modem is turned off

Digital IO LED

LED	Color	Function Description
DI1	Yellow	Light on, the channel is activated by input signal
DI2	Yellow	
DI3	Yellow	
DI4	Yellow	
DI5	Yellow	
DI6	Yellow	
DI7	Yellow	
DI8	Yellow	
DO1	Green	Light on, the channel output is activated
DO2	Green	
DO3	Green	
DO4	Green	

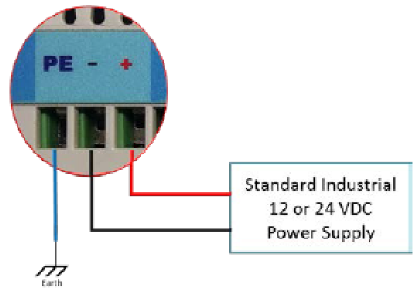
Analog Input LED

LED	Color	Function Description
AI1	Red	Light on, the channel value is below than 4mA for (4-20mA)
AI2	Red	
AI3	Red	
AI4	Red	

Communication LED

LED	Color	Function Description
Rx1	Red	Blinking, COM1 is sending data
Tx1	Green	Blinking, COM1 is receiving data
Rx2	Red	Blinking, COM2 is sending data
Tx2	Green	Blinking, COM2 is receiving data
Rx3	Red	Blinking, COM3 is sending data*
Tx3	Green	Blinking, COM3 is receiving data*
Eth1	Yellow	Active when at 100MB
Eth2	Green	Active when link present. Blinks off during activity

ATTENTION
This product is intended to be supplied by a Listed Power Unit with output marked “LPS” and rated for 9-36VDC (minimum requirements). For railway rolling stock applications, these devices must be supplied by a galvanic isolated power supply with design based on the EN 50155 standard.



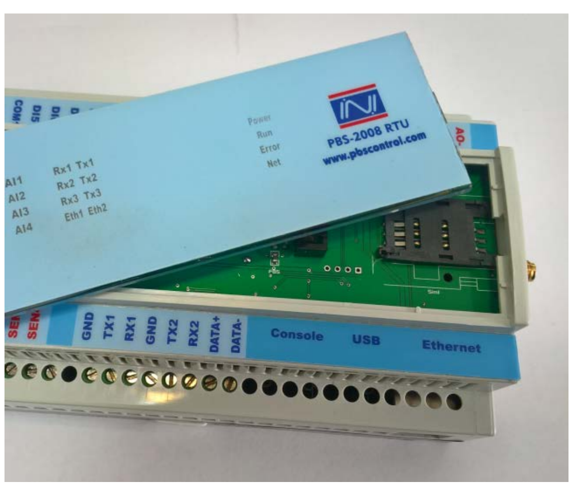
Resetting RTU Network Parameters (reset To Factory Setting) :

If you have problem with network IP address and system is not getting IP with DHCP Server or nay problem happened for Network Settings , you can reset network parameters as following :

- Connect Serial Port 1 TX to Serial Port 1 RX by a wire
- Connect Serial Port 2 TX to Serial Port 2 RX by a wire
- Make RTU Off and On
- After 1 Min When RTU is booted , RTU IP address is changed to 192.168.1.10 . this is depend to /etc/network/interfaces.default file content
- pbsSoftLogic Logic and configuration files also will be deleted .

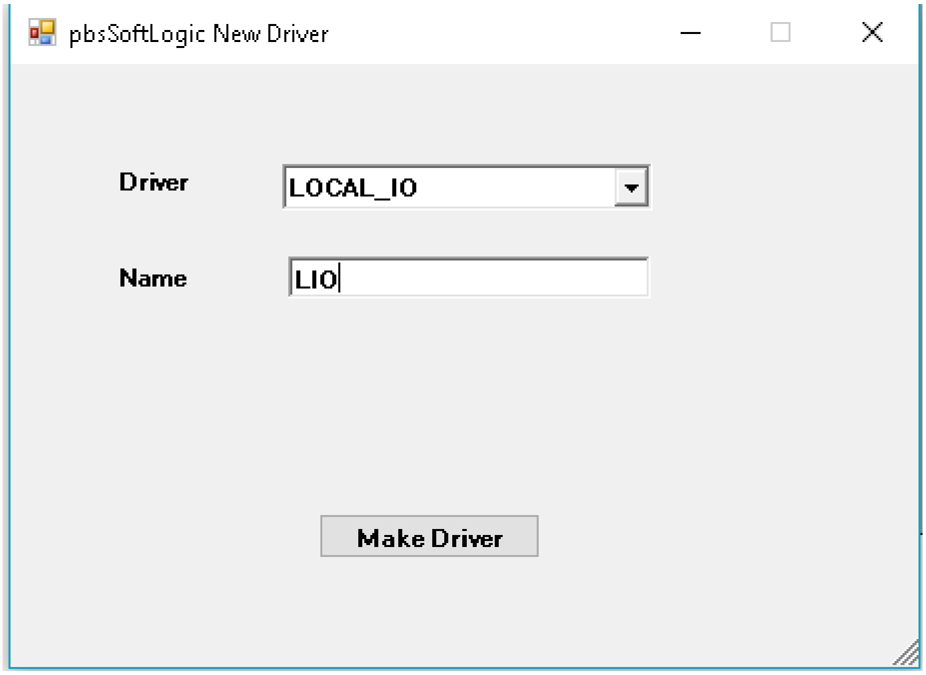
in this mode because there is no any hardware configuration for pbs2008RTU , so no LED will blink but RTU is booted and you can transfer logic and configuration to RTU .

Putting SIM Card: Put a minus screw Driver at Right Side of Top Cover of pbs2008RTU and open it. You can see SIM card location under top Cover.



Local IO configuration:

For using pbs2008 resources, you need to add Local_IO driver to project. Local_IO controls LEDs, Watch Dog, Local Digital Inputs , Analog Inputs , Digital Outputs and temperature Inputs . You can make 3G Modem Off / On by Local _IO Tags in your logic.



When you add Local_IO to your project, pbsSoftLogic will define following configuration file in driver directory.

```
<Tag Name="SYS.Reset" Type="SYS" Init="0" Address="0" />
<Tag Name="SYS.3GModemON" Type="SYS" Init="0" Address="1" />
<Tag Name="SYS.3GModemSignallevel" Type="SYS" Init="0" Address="2" />
<Tag Name="SYS.Temp1" Type="SYS" Init="0" Address="3" />
<Tag Name="SYS.Temp2" Type="SYS" Init="0" Address="4" />
<Tag Name="SYS.CNTTimer" Type="SYS" Init="200" Address="5" />
<Tag Name="SYS.AORange" Type="SYS" Init="1" Address="6" />
<Tag Name="SYS.Buzzer" Type="SYS" Init="0" Address="7" />
<Tag Name="SYS.IOScan" Type="SYS" Init="100" Address="8" />
<Tag Name="SYS.Total1" Type="SYS" Init="0" Address="9" />
<Tag Name="SYS.Total2" Type="SYS" Init="0" Address="10" />
<Tag Name="SYS.Total3" Type="SYS" Init="0" Address="11" />
<Tag Name="SYS.Total4" Type="SYS" Init="0" Address="12" />
<Tag Name="SYS.Total1RST" Type="SYS" Init="0" Address="13" />
<Tag Name="SYS.Total2RST" Type="SYS" Init="0" Address="14" />
<Tag Name="SYS.Total3RST" Type="SYS" Init="0" Address="15" />
<Tag Name="SYS.Total4RST" Type="SYS" Init="0" Address="16" />
<Tag Name="SYS.ChatterFilterCount" Type="SYS" Init="0" Address="17" />
<Tag Name="SYS.ChatterFilterBaseTimeMs" Type="SYS" Init="0" Address="18" />
<Tag Name="SYS.ChatterFilterFreezeTimeMs" Type="SYS" Init="0" Address="19" />
<Tag Name="SYS.3GConnected" Type="SYS" Init="0" Address="20" />
<Tag Name="SYS.3GModemSecIP1" Type="SYS" Init="192" Address="21" />
<Tag Name="SYS.3GModemSecIP2" Type="SYS" Init="168" Address="22" />
<Tag Name="SYS.3GModemSecIP3" Type="SYS" Init="1" Address="23" />
<Tag Name="SYS.3GModemSecIP4" Type="SYS" Init="15" Address="24" />
```

SYS.Reset : when change from 0 to 1 in logic , it will restart RTU

SYS.3GmodemOn : When changed from 0 to 1 , will make 3G Modem On , when changed from 1 to 0 , will make 3G modem off .

SYS.3GModemsignallevel: shows GPRS/3G Signal level in percentage

SYS.3GConnected: When value is 1 , it shows 3G Modem Got valid IP address from Mobile Network .This Signal is checking every Minute .

SYS.3GModemSecIP1 , SYS.3GModemSecIP2 , SYS.3GModemSecIP3, SYS.3GModemSecIP4 :

This is second Virtual IP address for 3G Modem. In above example 3G modem Second IP is 192.168.1.15

SYS.Temp1, SYS.Temp2: shows DS18b20 Digital Temperature sensor value.

SYS.CNTTimer : four DI channels of pbs2008RTU can be used as counter .SYS.CNTTime is base timer for doing counting in IO CPU . it's unit is msec .

SYS.AORange : pbs2008RTU has one AO channel as option .SYS.AORange shows AO Signal Range as following :

SYS.AORange = 1 , 4~20 mA

SYS.AORange = 2 , 0~20 mA

SYS.Buzzer : When changed to 1 in logic will activate RTU buzzer .

SYS.IOScan: this parameter is used in pbsSoftLogic Local IO Driver for pbs2008RTU to read/Write Local I/Os of RTU. Typical value is 100 msec .

SYS.Total1 , 2 , 3, 4 : Shows Total Pulse counted for DI channels 1 ,2,3 and 4 .

SYS.Total1RST , Total2RST , Total3RST , Total4RST: When changed from 0 to 1 in logic , it will reset SYS.Total1 , SYS.Total2, SYS.Total3 and SYS.Total4 values .

SYS.ChatterFilterCount , SYS.ChatterFilterBaseTimeMS,SYS.ChatterFilterFreezeTimeMS

Pbs2008RTU has built in Chatter Filter for DI channels. Chatter filter calculation is handling in IO CPU .But Parameter should pass from Local IO Driver. Typical value for chatter filters parameters:

ChatterFilterCount = 10

ChatterFilterBaseTime = 1000msec

ChatterFilterFreezeTime = 2000 msec

When DI signal is changed for 10 times (ChatterFilterCount) in 1000 msec (ChatterFilterBaseTime) then DI value will freeze for 2000 msec (ChatterFilterFreezeTime)

-When chatter happening bit 7 of DITagx will set to 1

- When there is no chattering bit 7 of DITagx will set to 0

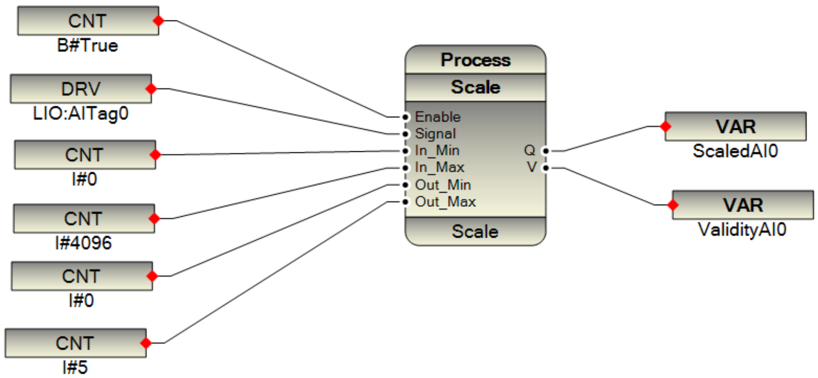
DITagX Value:

- If Signal is 0 and Chatter happened 128
- If Signal is 1 and Chatter happened 129
- If Signal is 0 and Chatter not happened 0
- If Signal is 1 and Chatter not happened 1

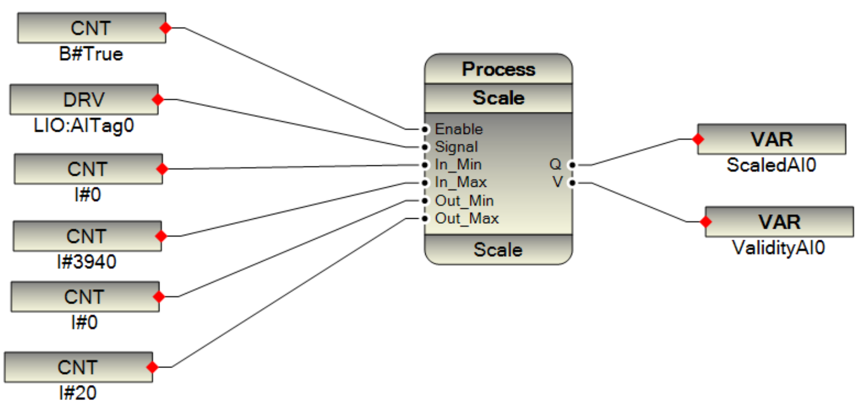
AITag0 , AITag1 , AITag2 , AITag3 : Shows value of Analog input Signals

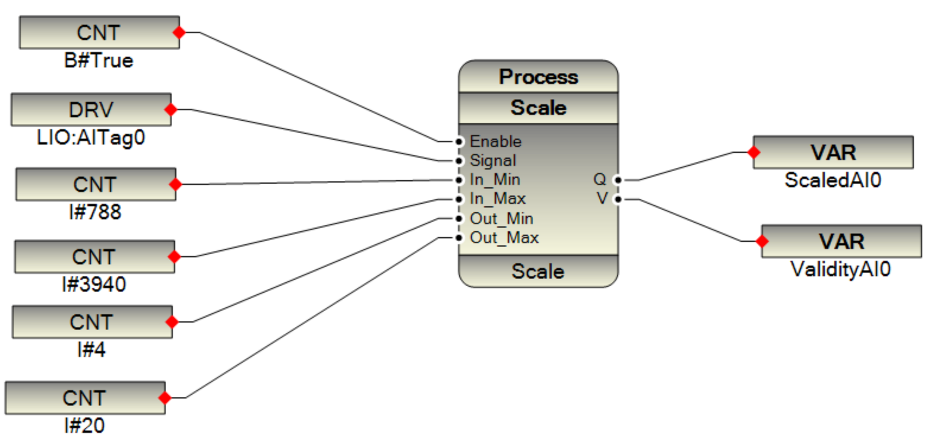
Analog input in pbs2008RTU has 12 bit resolution. You can set AI Range by Switches in back side of RTU.

If Analog Input Signal is set to Voltage mode, then Value of Signal is changing between 0 to 4096. You can use Scale Function block for scaling signal to actual value.



If Analog Input Signal is set to Current Mode then 0 to 20 mA will map to 0 to 3940. For scaling you can use scale Function block for 0~20 mA and 4~20 mA as following samples :





DITag0 to DITag7 : Shows Value of Digital Input Signals with Chatter Filter Status Signal

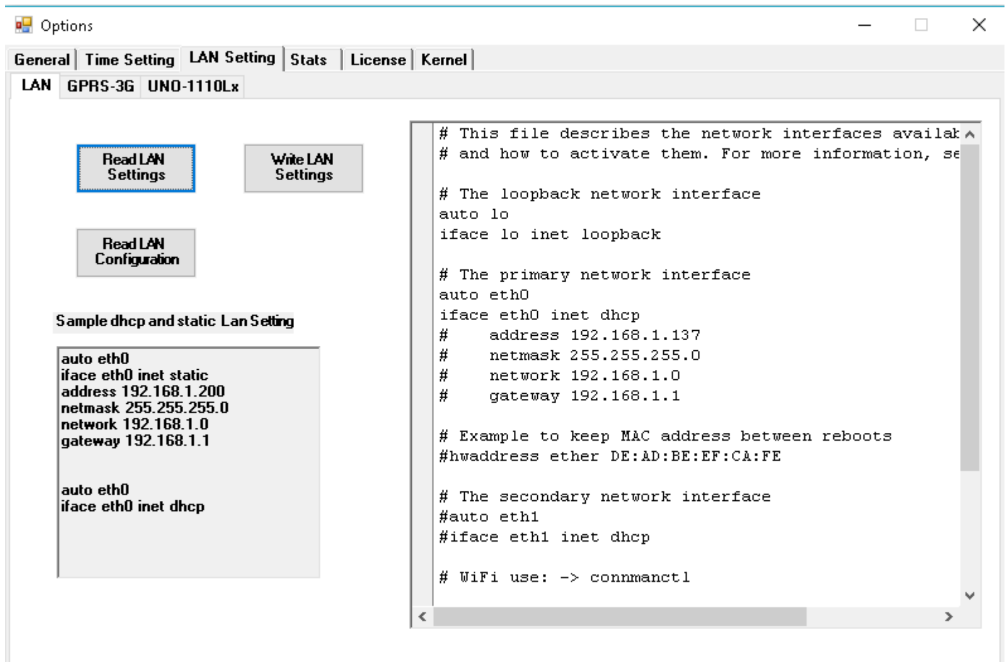
DOTAg0 , DOTAg1 , DOTAg2 and DOTAg3 : Read/Write DO signals in logic .

CNTTag0 , CNTTag1 , CNTTag2 , CNTTag3 : Shows Counter Value of four DI channels .Maximum you can count 1 KHz Pulses .

AOTag0: Read/Write Value of Analog Output Signal by logic .

Changing LAN Settings:

For changing LAN Settings you can use pbsSoftLogic. Open project Option page and select LAN Setting Tab:



Pbs-2008RTU eth0 (LAN) port default setting is 192.168.1.137 (like above page) or it is dhcp .

Click on Read LAN setting Button, it will show all LAN setting of pbs-2008RTU. eth0 is name of RTU LAN port.

Change setting as following for dhcp configuration:

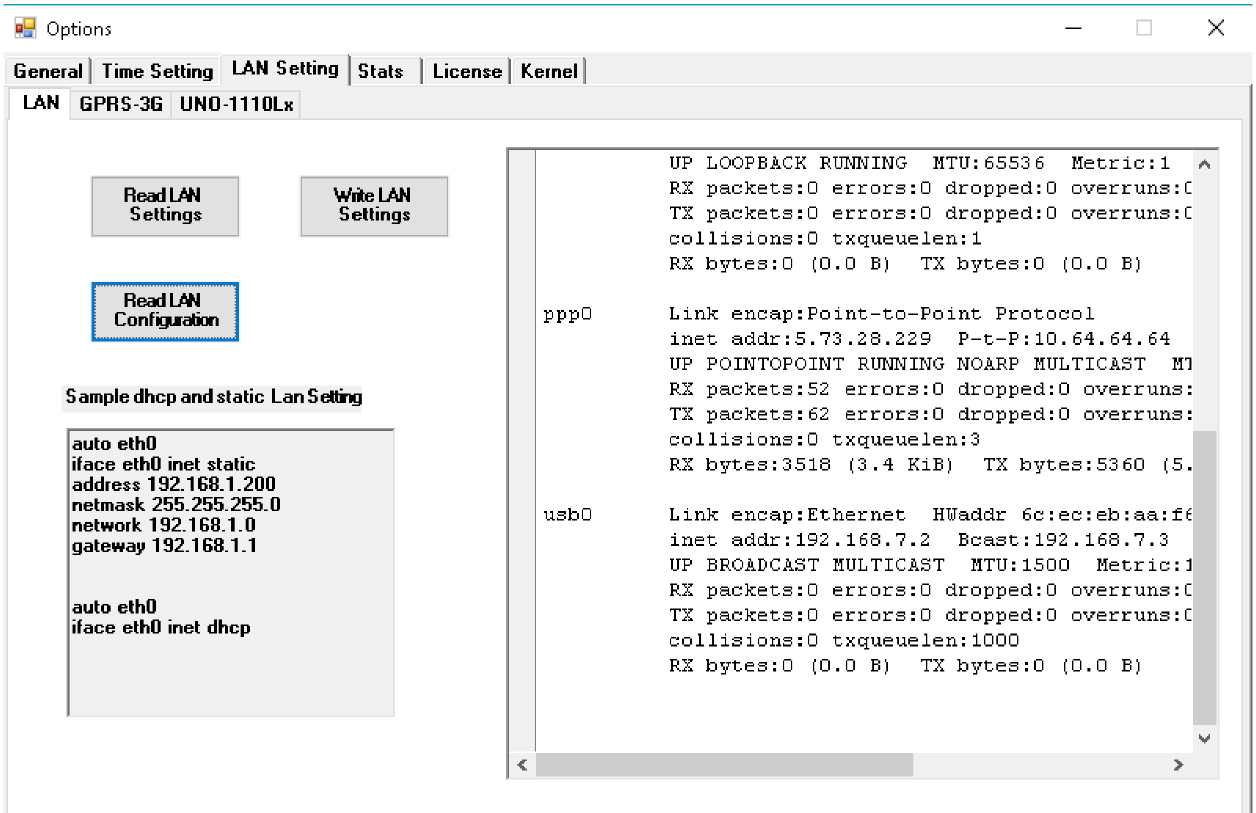
```
auto eth0
iface eth0 inet dhcp
```

Change settting as following for Static IP configuration:

```
auto eth0
iface eth0 inet static
address 192.168.1.200
netmask 255.255.255.0
network 192.168.1.0
gateway 192.168.1.1
```

After changing settings, click on Write LAN setting button. When you restart RTU, it will get new IP setting.

Click on Read LAN Configuration, you can see all LAN configuration of RTU(it is equal to ifconfig command of linux)



If 3G modem is ON and connected to network then you can see ppp0 in list of TCP/IP

Setting GPRS/3G Modem Parameters:

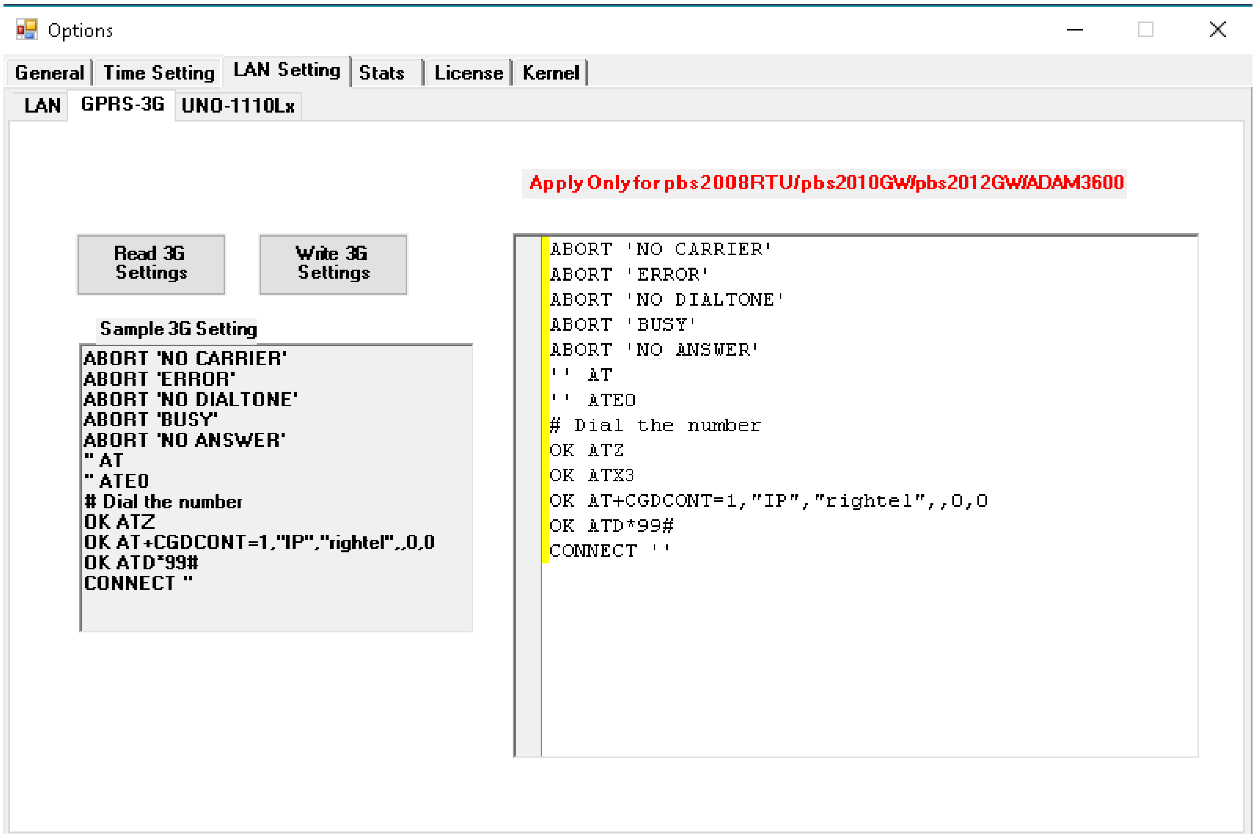
Pbs-2008RTU has a built in 3G Modem for communication with master SCADA . You can make modem Off/On from logic by help of SYS.3GModemOn Local_IO signal .

When you set SYS.3GModemOn to 1 , it will make Modem On . Net LED will start to blink.

When you set SYS.3GModemOn to 0 , it will make modem off .

When Modem is On and connected to network , you can see configuration by clicking on Read Configuration Button . ppp0 is port name for 3G modem .

For setting APN name, select GPRS-3G tab:



In above page change rightel APN name to your service provider name and to be sure that connect command to modem is *99#.

After Settings changed, click on Write 3G Settings and restart RTU.

3G Communication Notes:

- If you only have dynamic IP address for RTUs , then you can use GSPClinet driver to communicate with Master SCADA (You need to have one Fix and valid IP address for SCADA Master)
- By using SQLite Driver and usig MS SQL Server automatic data synchronization, you can use dynamic IP address for RTUs and again you need one Fixed and valid IP address for SQL Server in Master control room.
- Other protocols like Modbus TCP, DNP3, IEC104, OPC UA they need static IP address for all RTUs.

Updating pbs2008RTU Runtime Kernel:

- Download latest Runtime kernel from www.pbscontrol.com web site
- Run telnet and connect to RTU . by default User name and password is root ,root.

```
Telnet 192.168.1.137
Debian GNU/Linux 8

BeagleBoard.org Debian Image 2016-07-10

Support/FAQ: http://elinux.org/Beagleboard:BeagleBoneBlack_Debian

default username:password is [debian:temppwd]

pbs2008_137 login: root
Password:
Last login: Fri Feb 24 15:17:09 IRST 2017 from kamjooT420 on pts/1
Linux pbs2008_137 4.4.14-bone11 #8 Wed Jul 13 21:32:55 IRDT 2016 armv7l

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
root@pbs2008_137:~#
```

- go to /home/pbsLX and remove logic.cfg and logic.c11 files by rm command

```
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
root@pbs2008_137:~# cd /home/pbsLX/
root@pbs2008_137:/home/pbsLX# rm logic.cfg
```

```
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
root@pbs2008_137:~# cd /home/pbsLX/
root@pbs2008_137:/home/pbsLX# rm logic.c11
```

- restart RTU by reboot command

```
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
root@pbs2008_137:~# cd /home/pbsLX/
root@pbs2008_137:/home/pbsLX# reboot
```

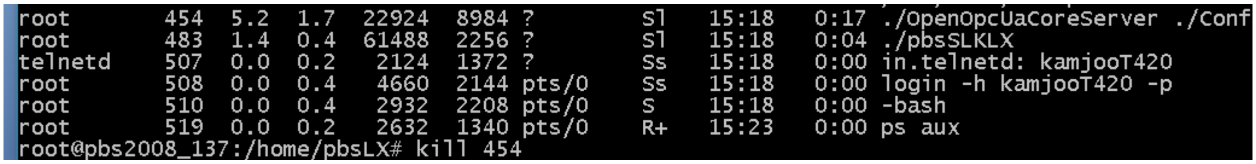
-
- again connect to RTU by telnet and kill pbsSLKLX by pkill command

```
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
root@pbs2008_137:~# cd /home/pbsLX/
root@pbs2008_137:/home/pbsLX# pkill pbsSLKLX
```

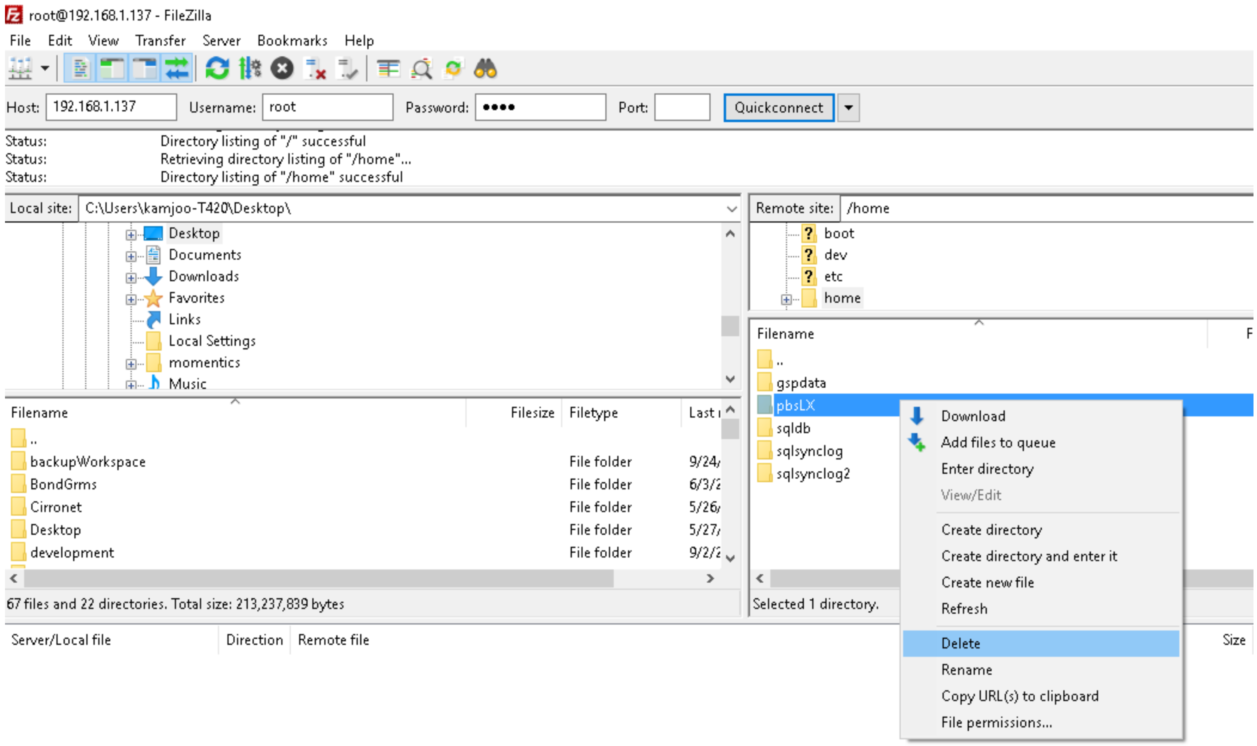
- run ps aux command and check is there OpenOPCUaCoreServer program in program list , If exist kill it by Process ID

```
root@pbs2008_137:/home/pbsLX# ps aux
```

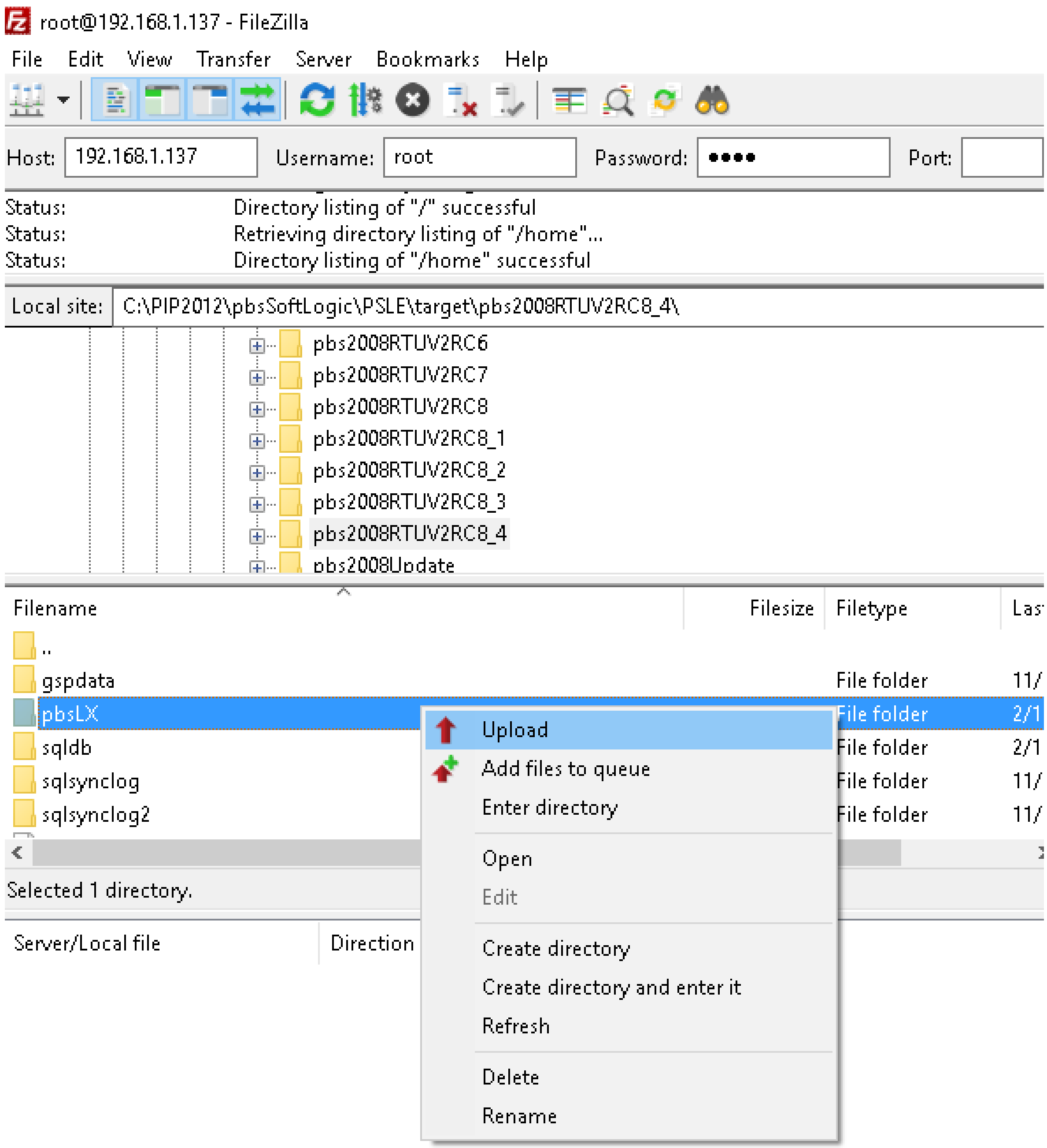
-

- 

- If OpenOpcUaCioreServer is exist kill it by ID , in above example Process ID is 454
- Check that both pbsSLKLX and OpenOpcUaCoreServer is not in task List .
- run Filezilla and delete /home/pbsLX directory



-
- copy new pbsLX directory to /home/pbsLX



-
- transfer your logic and configuration
- restart RTU

For Proper setting of Filezilla please refer to chapter 11 . Otherwise you may damage RTU

OpenVPN client on pbs2008RTU

Pbs2008RTU Operating system is Standard Debian Linux .We installed before OpenVPN Package on all RTUs , but you can install by following steps on RTU :

- connected pbs2008RTU to Internet (Change Its IP Address to DHCP and connect it to a Internet Router with DHCP Server functionality)
- Connect to RTU by telnet and run "apt-get install openvpn " command . It will download and install openvpn package from Debian Repository .
- If openvpn package installed before and it is updated you will see following message :

```
root@pbs2008_137:~# apt-get install openvpn
Reading package lists... Done
Building dependency tree
Reading state information... Done
openvpn is already the newest version.
0 upgraded, 0 newly installed, 0 to remove and 43 not upgraded.
root@pbs2008_137:~#
```

- Following files will be installed in RTU :

Full Path and File Installed by OpenVPN	Function
/etc/openvpn	Directory containing configuration files
/etc/network/if-up.d/openvpn /etc/network/if-down.d /etc/network/if-down.d/openvpn	Start/stop openvpn when the network goes up/down
/etc/init.d/openvpn	Start/stop script for services
/sbin/openvpn	The binary
/usr/share/doc/openvpn	Documentation files
/usr/share/man/man8/openvpn.8.gz	Manual page
/usr/share/doc/openvpn/examples/sample-config-files	Example configuration files
/usr/share/doc/openvpn/examples/sample-keys	Example keys
/usr/share/doc/openvpn/examples/easy-rsa	easy-rsa—a collection of scripts useful for creating tunnels
/usr/share/doc/openvpn/changelog.Debian.gz /usr/share/doc/openvpn/changelog.gz	Version history
/usr/share/openvpn/verify-cn	verify-cn function (revoke command)
/usr/lib/openvpn/openvpn-auth-pam.so /usr/lib/openvpn/openvpn-down-root.so	Libraries for PAM-Authentication and chroot mode

Setting symmetric key encryption in both side

You need to provide encryption key for RTU to connect with Server. Same key file should be used in server.

In windows make a new key file with following command:

openvpn.exe --pause-exit --verb 3 --genkey --secret "C:\OpenVPN\config\key.txt"

Before running above command you should install openvpm on your windows station. Please look at www.openvpn.net for getting openvpn for windows.

By filezilla transfer openvpn sample configuration file from C:\Program Files\OpenVPN\sample-config and generated key file to to pbs2008 to /home/openvpn directory.

You need to set three parameters in sample configuration file to connect to openvpn server:

-remote : Real IP address of Server .

-ifconfig : Virtual IP address of RTU

- secret : put path of key file

For making connection to server only run openvpn with following command:

openvpn --config sample.ovpn

If server is configured properly then RTU will connect to server and you can see a new virtual IP address is included in RTU . use ifconfig command to check interface :

```
root@beaglebone:~# ifconfig
eth0      Link encap:Ethernet  HWaddr 98:5d:ad:4a:cb:6a
          inet addr:192.168.1.225  Bcast:192.168.1.255  Mask:255.255.255.0
          inet6 addr: fe80::9a5d:adff:fe4a:cb6a/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:23714 errors:0 dropped:0 overruns:0 frame:0
          TX packets:2249 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:2701496 (2.5 MiB)  TX bytes:644309 (629.2 KiB)
          Interrupt:40

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

tap0      Link encap:Ethernet  HWaddr 3a:b8:39:ae:8a:43
          inet addr:10.3.0.2  Bcast:10.3.0.255  Mask:255.255.255.0
          inet6 addr: fe80::38b8:39ff:feae:8a43/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:6355 errors:0 dropped:8 overruns:0 frame:0
          TX packets:933 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:100
          RX bytes:620106 (605.5 KiB)  TX bytes:394649 (385.3 KiB)

usb0      Link encap:Ethernet  HWaddr 98:5d:ad:4a:cb:60
          inet addr:192.168.7.2  Bcast:192.168.7.3  Mask:255.255.255.252
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
```

tap0 is new virtual interface for RTU . tap0 is like a normal eth0 or ppp0 interface and you can use it in pbsSoftLogic for doing protocol configuration .

Setting X509 Certificate

File	Location and purpose
VPN-Server.crt	Signed certificate of the VPN-Server, must be on VPN-Server
VPN-Server.key	Private RSA key of the VPN-Server, must be on VPN-Server
VPN-Server.csr	Certificate signing request of VPN-Server, can be deleted
VPN-client.crt	Signed certificate of the VPN-client, must be on VPN-client
VPN-client.key	Private RSA key of the VPN-client, must be on VPN-client
VPN-client.csr	Certificate Signing request of VPN-Client, can be deleted
ca.crt	CA certificate, must be available on both machines
ca.key	The key to the CA, must be kept only on CA; must be kept very secret
dh2048.pem	The Diffie-Hellman key, must only be available on VPN-Server

For connection of pbs2008RTU to an OpenVPN Master by X509 certificate you need to get following files from OpenVPN Master configurator Team for your RTU:

XXXX.crt signed Certificate

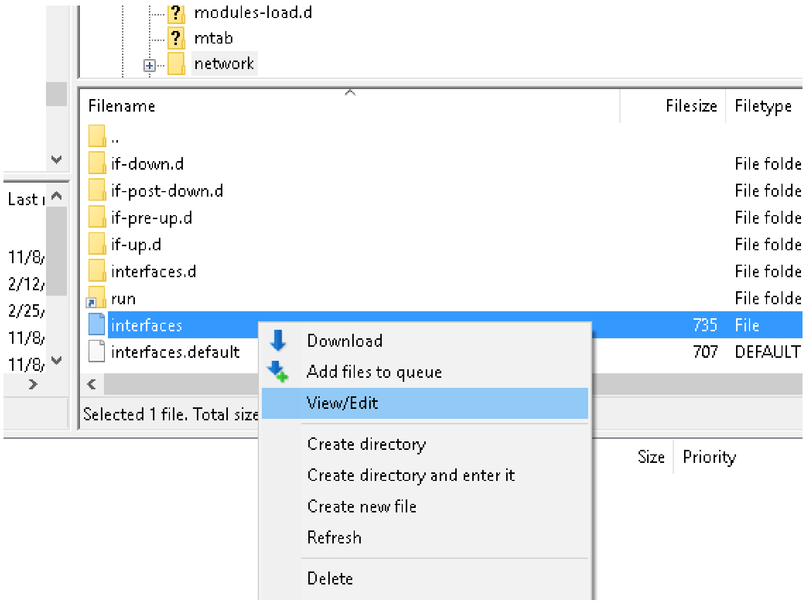
XXXX.Key private RSA key of RTU

Ca.key the key to CA

Make a directory in /home/openvpn and copy above files by filezilla to /home/openvpn directory .

Changing IP address by FileZilla :

- Run filezilla client software and connect to RTU . default user and pass is root ,root
- View/edit /etc/network/interfaces file by notepad ++ utility



-
- Change IP address for static as following for eth0 port :

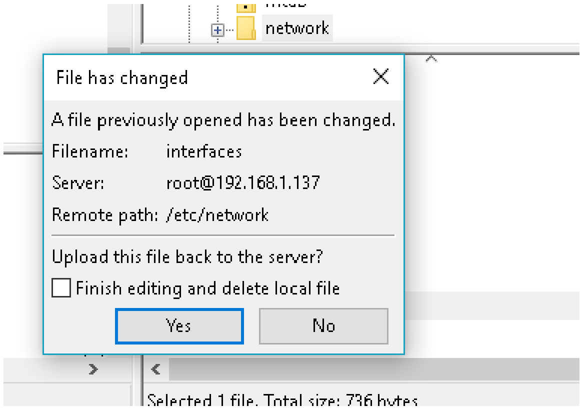
```
# The loopback network interface
auto lo
iface lo inet loopback

# The primary network interface
#auto eth0
#iface eth0 inet dhcp
auto eth0
iface eth0 inet static
address 192.168.1.137
netmask 255.255.255.0
```

-
- Save file and exit notepad++
- If you want to change IP to dhcp change it as following :

```
# The primary network interface
auto eth0
iface eth0 inet dhcp

#auto eth0
#iface eth0 inet static
#address 192.168.1.137
#netmask 255.255.255.0
```

-

- Confirm write to RTU in filezilla software .



-
- When using filezilla always check that file transfer is set in Binary . otherwise filezilla will damage linux file in transfer .
- For editing linux file always use Notepad+ , otherwise when you edit files in windows it will damaged file by simple editor like notepad .

21 – ADAM-3600 , UNO1252G and UNO1110 Configuration .

ADAM-3600 is new RTU from Advantech Company. ADAM-3600 has following specifications:

- **TI AM33352 A8 600MHz CPU**
- **DDR3L 256 MB , Battery Backup RAM 32KB , Standard SD 512MB /Micro SD**
- **On-board IO-8AI /8DI/4DO**
- **Wireless communication- Zigbee/ wifi/ 3G/GPRS**
- **Embedded Linux OS**
- **Operation Temperature: -40~70°C**
- **COM1: RS-232/RS-485**
- **COM2&COM3:RS-485**
- **LAN1/LAN2 Ethernet**
- **LED Indicators: DI/DO/PWR/RUN/Serial Port**

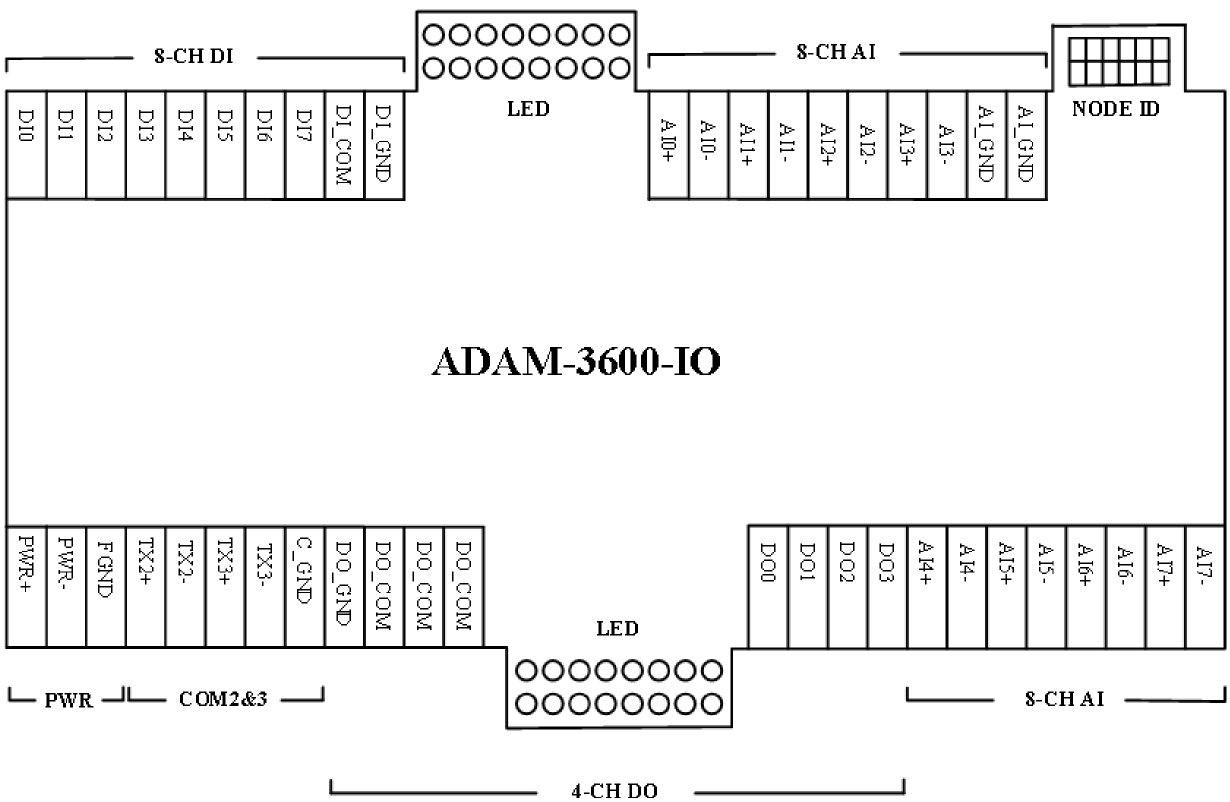
On-board I/O

Analog Input
■ Channels： 8 differential
■Resolution：16-bit
■ Input Type: ±10V, ±2.5 V，0~20mA, 4~20mA
■ Isolation Voltage: 2000VDC
Digital Input
■Channels： 8
■Input Type: Wet Contact Input (Sink)
■ Protection Voltage: +40VDC
■ Isolation Voltage: 2000VDC

Digital Output
■Channels: 4
■Output Type: Open Collector (Sink)
■ Rated Voltage: 8~30VDC

General

- **Certifications CE, FCC Class A, UL**
- **Power supply 9~36VDC**
- **Operation Temp. -40°C – 70°C**
- **Storage Temp. -40°C – 85°C**
- **Humidity 5~95% (no condensation)**
- **Dimensions 223.5* 110* 60.5mm**
- **Mounting DIN-Rail/ Wall-mount**



CPU	TI Cortex-A8 AM3352BZCZD60	
RAM	DDR3 256MB Battery Backup RAM 32KB	
Communication Interface	1x RS232/485 2x RS485 2x LAN 10/100Mbps 1x USB 2.0 1x VGA	
On-board I/O	8AI: 0~20mA, 4~20mA, ±10V, ±2.5 V 8DI: Wet Contact (Sink) 4DO: Open Collector (Sink)	
Extension	4-Slot	
	I/O Module	AI/ DI/ DO/Extension I/O Module
Wireless	WIFI/GPRS/3G	Mini-PCIe with USB Signal
	Zigbee	Zigbee Converter / Mini-PCIe with RS-232 Signal
SD Storage	512MB Micro SD/ Standard SD	

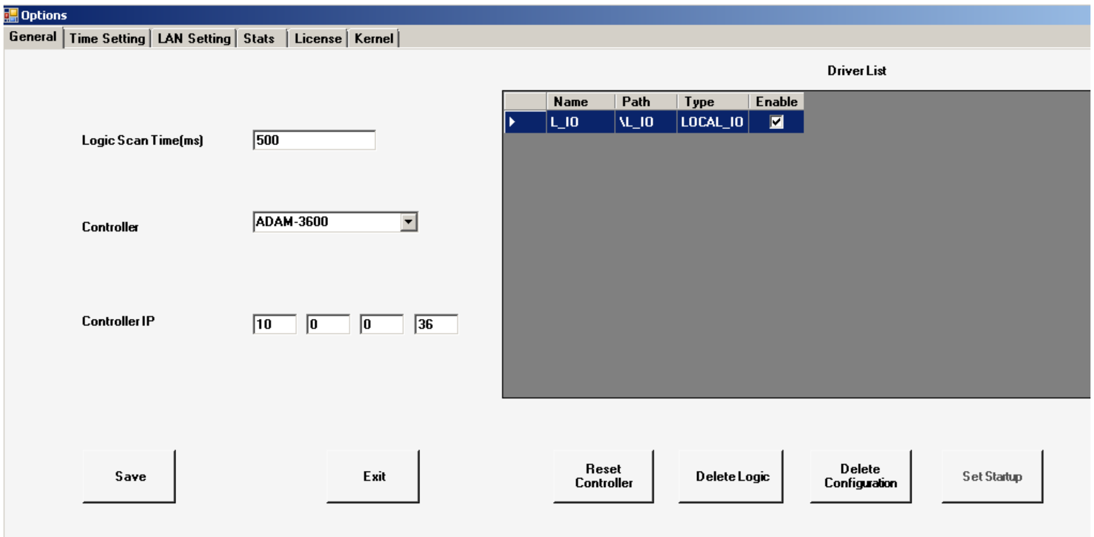
Power Requirement	9~36VDC
Operation Temperature	-40~70℃
Operation System	Real-time Linux kernel 3.2
Programming Language	pbsSoftLogic 1.7
Communication Protocol	Modbus RTU/TCP, DNP3.0 ,IEC870-5-101/104
Intelligent Function	(1) Function block and Lua Scripting language (2)Remotely start and stop device (3) Data cache during network break-off (4) Remotely upgrade firmware and customer APP (5) Monitor RTU operation status (6) Device status Self-detection (7) Failure alarming

Expansion IO Module specification

Analogue Input	Channel	8, differential	_	4, differential	4, differential				
	Sample /sec	10		10	10				
	Voltage Input	+/- 10V +/- 2.5V		+/- 10V +/- 2.5V					
	Current Input	0-20 mA 4~20mA		0-20 mA 4~20mA					
	Sensor Input				Thernal Couple (Type J,K,T,E,R,S,B)				
	Resolution	16-bit		16-bit	16-bit				
Analogue Output	Channel	-	-			2			
	Voltage Output					0~10V			
	Current Output					0-20 mA 4~20mA			
	Resolution					12-bit			
Digital Input	Channel	8	16				8		
	Type	Sink	Sink				Sink		
	Rated Voltage	12/24VDC	12/24VDC				12/24VDC		
	Logic "0"	0~5VDC	0~5VDC				0~5VDC		
	Logic "1"	11~30VDC	11~30VDC				11~30VDC		
Digital Output	Channel	4	8					8	4
	Type	Sink	Relay Type A, SPST					Sink	Relay Type A, SPST
	Output Voltage	DC:8~30V @max 200mA	AC: 250V@5A DC: 30V@3A					DC:8~30V @max 200mA	AC: 250V@5A DC: 30V@3A
P/N		ADAM-3600-C2GL1AE	ADAM-3600-A2GL1AE	ADAM-3617-AE	ADAM-3618-AE	ADAM-3622-AE	ADAM-3651-AE	ADAM-3656-AE	ADAM-3664-AE

ADAM-3600 Software Configuration

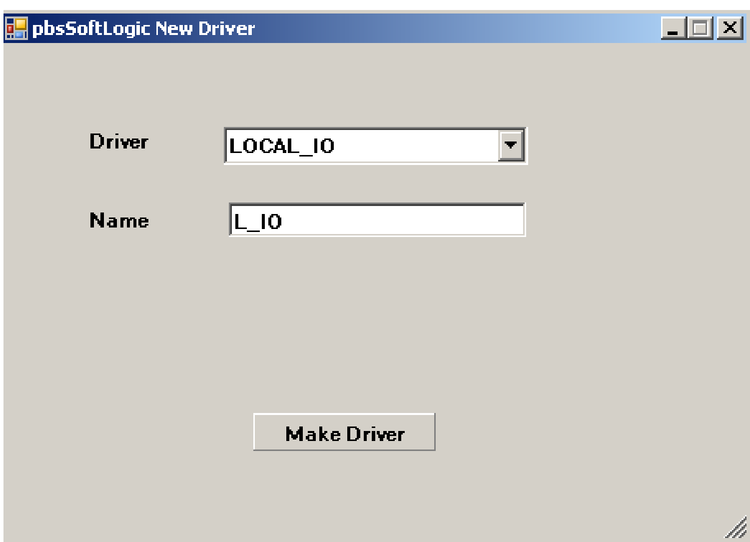
For configuration and programming of ADAM-3600 you need to download pbsSoftLogic V1.6.5 or newer version from www.pbscontrol.com



From Controller list select ADAM-3600.

Set Controller IP address.

Right click on driver list and select New Driver and select Local_IO.



Driver name should be unique in configured drivers for a controller.

Click on make driver button. pbsSoftLogic will make basic configuration file in driver directory (Local_IO.xml) in configuration file you can only change Name of signals . Name should be unique .

```
<Tag Name="AITag0" Type="AI" Init="0" Slot="-1" Address="0" Range="4-20" />
<Tag Name="AITag1" Type="AI" Init="0" Slot="-1" Address="1" Range="4-20" />
<Tag Name="AITag2" Type="AI" Init="0" Slot="-1" Address="2" Range="4-20" />
<Tag Name="AITag3" Type="AI" Init="0" Slot="-1" Address="3" Range="4-20" />
<Tag Name="AITag4" Type="AI" Init="0" Slot="-1" Address="4" Range="4-20" />
<Tag Name="AITag5" Type="AI" Init="0" Slot="-1" Address="5" Range="4-20" />
<Tag Name="AITag6" Type="AI" Init="0" Slot="-1" Address="6" Range="4-20" />
<Tag Name="AITag7" Type="AI" Init="0" Slot="-1" Address="7" Range="4-20" />
<Tag Name="DITag0" Type="DI" Init="0" Slot="-1" Address="0" />
<Tag Name="DITag1" Type="DI" Init="0" Slot="-1" Address="1" />
<Tag Name="DITag2" Type="DI" Init="0" Slot="-1" Address="2" />
<Tag Name="DITag3" Type="DI" Init="0" Slot="-1" Address="3" />
<Tag Name="DITag4" Type="DI" Init="0" Slot="-1" Address="4" />
<Tag Name="DITag5" Type="DI" Init="0" Slot="-1" Address="5" />
<Tag Name="DITag6" Type="DI" Init="0" Slot="-1" Address="6" />
<Tag Name="DITag7" Type="DI" Init="0" Slot="-1" Address="7" />
<Tag Name="DOTag0" Type="DO" Init="0" Slot="-1" Address="0" />
<Tag Name="DOTag1" Type="DO" Init="0" Slot="-1" Address="1" />
<Tag Name="DOTag2" Type="DO" Init="0" Slot="-1" Address="2" />
<Tag Name="DOTag3" Type="DO" Init="0" Slot="-1" Address="3" />
```

pbsSoftLogic will make initial file for Local IO configuration .

For Analog signals you should set Range for proper operation.

By default analog signals range is 4-20 mA . you can set following ranges for analog signals :

“-10-10” = - 10 to + 10 VDC

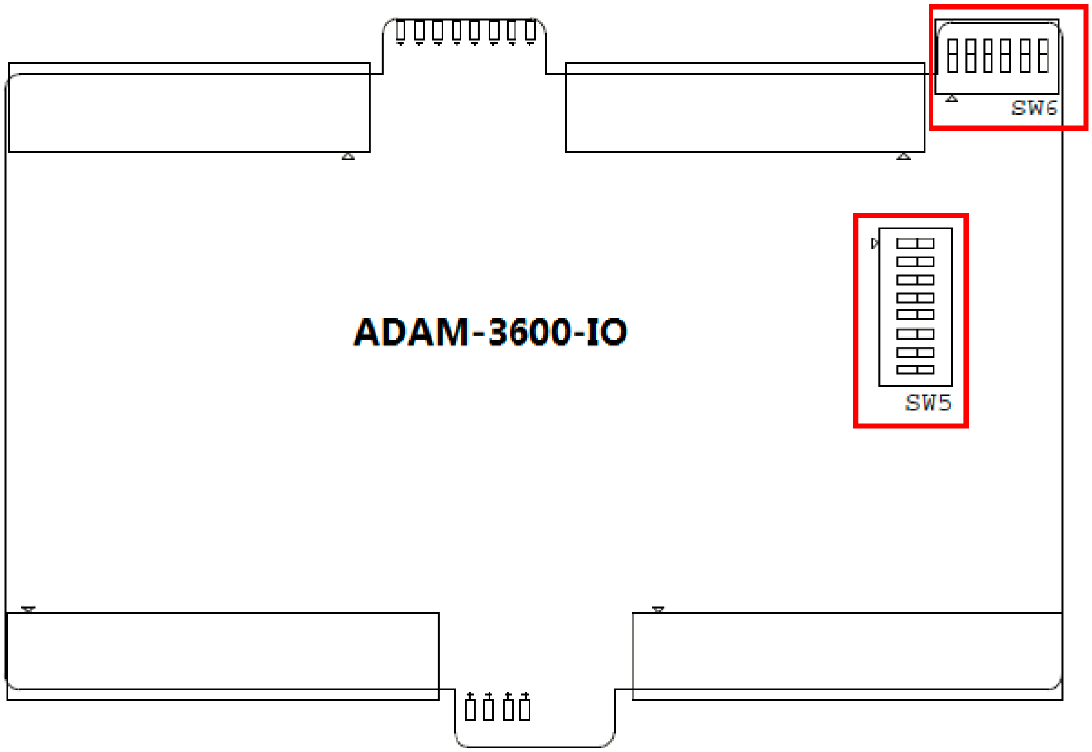
“-2.5-2.5” = -2.5 to +2.5 VDC

,”0-20” = 0 to 20 mA

”4-20” = 4 to 20 mA

You should set SW5 for selecting between voltage and Current for analog signals. You can set each channel independently as current or voltage.

ADAM-3600 DIP Switch Setting			
No.	Name	Meaning	Description
1	SW6	Node ID	6-bit，support 0~63 devices ON-1/ OFF-0 1 is for high bit, 6 is for last bit, ex: [0 0 0 0 0 1] = 1 [1 0 0 0 0 0] = 32
2	SW5	8-ch AI Current or voltage range select	ON- Current OFF- Voltage



Note: When you define local IO for ADAM-3600, Then Watch dog Timer, Run LED and NodeID will activate on RTU.

When you define Local IO for ADAM-3600, then Watch dog timer will set to 10 sec.

Run LED will start to blink based on Logic scan time.

When SW5 is set to ON then Watch dog Timer will activate.

When SW5 is set to ON then Watch dog Timer will disable.

UNO1252G Configuration

pbsSoftLogic supports UNO1252G with Yocto Linux .

UNO-1252G-RTU

Intel® Quark Micro DIN-rail Gateway w/ 2 x LAN, 2 x mPCle, 2 x COM, 8 x DI/O, 2 x USB, 1 x 1GB microSD card, 1 x SIM

Features

- Intel® Quark X1001 400 MHz Processor with 256MB Memory
- 2 x LAN, 2 x mPCle, 1 x RS-232, 1 x RS-232/485, 8 x DI/O, 2 x USB, 1 x 1GB microSD card, 1 x SIM
- COM ports and Digital I/O with Isolation Protection design for Sensing and Controlling
- Chassis Grounding Protection
- Compact with Fanless Design
- DIN-rail mounting design
- Supports GPRS/3G/GPS/Wi-Fi Communication by iDoor Technology
- Supports Embedded Linux OS
- Supports pbsSoftLogic IEC1131-3 Based programming Language with Function Block and Lua Scripting
- Supports Modbus TCP/RTU Master/Slave
- IEC870-5-104 Slave , DNP3 Slave , SQLite with automatic MS SQL Data Synchronization , OPC UA Server

Specifications

General

- **Certification** CE, FCC, CCC, BSMI, UL
- **Dimensions (W x D x H)** 63 x 105 x 100 mm (2.48" x 4.13" x 3.94")
- **Form Factor** Micro Size
- **Enclosure** Aluminum Housing
- **Mounting** DIN-rail
- **Weight (Net)** 0.6 kg (1.33 lbs)
- **Power Requirements** 10~36 V_{DC}
- **Power Consumption** 6 W (Typical)
- **OS Support** Embedded Linux

System Hardware

- **BIOS** 8MB SPI Flash
- **Processor** Intel Quark X1001 400 MHz
- **System Chip** Integrated Intel SoC Chipset
- **Memory** On-board 256 MB DDR3 800 MHz
- **LED Indicators** LEDs for Power (PWR) , battery (BTR), COM1~2 (Tx/Rx) and microSD (SD), Programmable Indicators (PL1~3)
- **Storage** 1 x microSD Slot (32GB microSD card included)
- **Expansion** 1 x Full-size mPCle with USB signal, 1 x Full-size mPCle with PCle signal, 1 x iDoor I/O front plate

I/O Interfaces

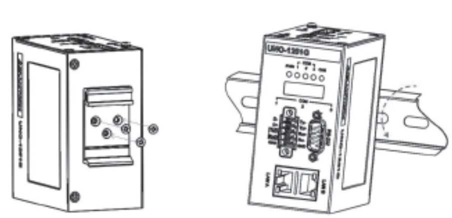
- **Isolated Serial Ports** 1 x RS-232, DB9, 50~115.2 kbps, supports console debug; 1 x RS-232/485, DB9, 50~115.2 kbps (Isolation Protection 1000 V_{DC})
- **LAN Ports** 2 x RJ45, 10/100 Mbps (DHCP supported by LAN A)
- **USB Ports** 1 x USB 2.0 (type-A), 1 x USB Client (micro-B)
- **Isolated DI/O** 4-ch digital input, 4-ch digital output (Isolation Protection 1000 V_{DC} , Overvoltage protection 30 V_{DC})
- **Power Connector** 1 x 3 Pin, Terminal Block
- **Grounding Protection** Chassis Grounding
- **SIM** 1 x SIM card slot

Environment

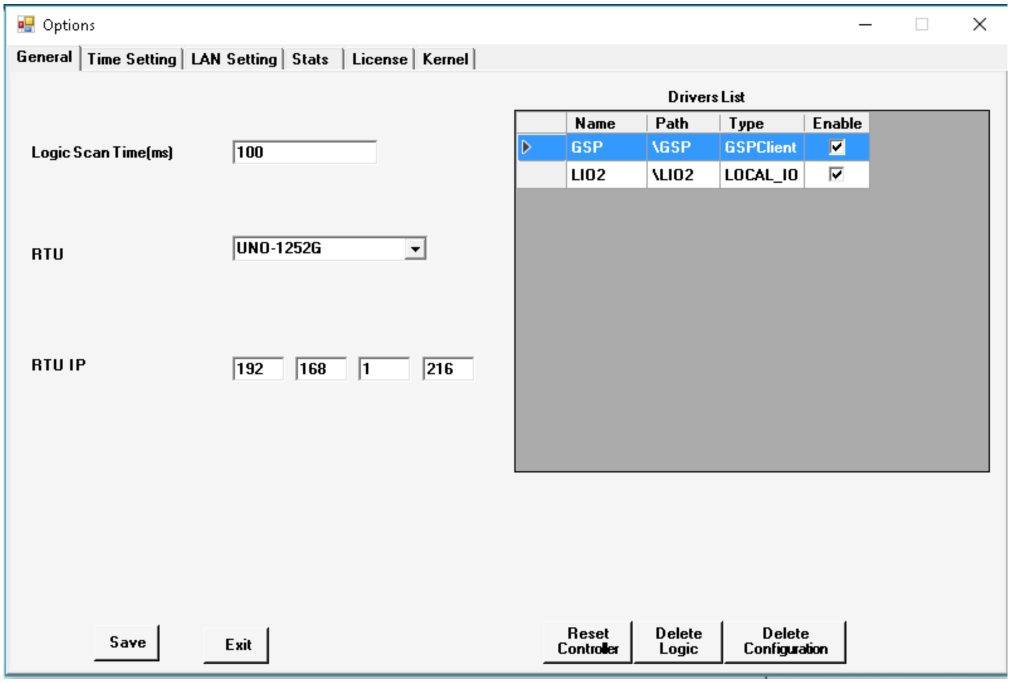
- **Operating Temperature** - 20 ~ 60°C (-4 ~ 140°F) @ 5 ~ 85% RH
- **Storage Temperature** - 40 ~ 85°C (-40 ~ 185°F)
- **Relative Humidity** 10 ~ 95% RH @ 40°C, non-condensing
- **Shock Protection** Operating, IEC 60068-2-27, 50G, half sine, 11ms
- **Vibration Protection** Operating, IEC 60068-2-64, 2 Grms, random, 5 ~ 500Hz, 1 hr/axis

Installation Scenario

DIN-rail Mount Illustration



Like other RTUs you need to define Local IO to use UNO1252G resources .



In project setting page , select UNO-1252G as RTU type and define New Local IO . pbsSoftLogic will add following file to your project configuration .


```
<?xml version="1.0"?>
<OPCSrvTags>
     <Version>1.0.0</Version>
     <Tag Name="SYS.Reset" Type="SYS" Init="0" Address="0" />
     <Tag Name="SYS.3GModemON" Type="SYS" Init="0" Address="1" />
     <Tag Name="SYS.3GModemSignallevel" Type="SYS" Init="0" Address="2" />
     <Tag Name="SYS.Buzzer" Type="SYS" Init="0" Address="3" />
     <Tag Name="SYS.IOScan" Type="SYS" Init="100" Address="4" />
     <Tag Name="DITag0" Type="DI" Init="0" Address="0" />
     <Tag Name="DITag1" Type="DI" Init="0" Address="1" />
     <Tag Name="DITag2" Type="DI" Init="0" Address="2" />
     <Tag Name="DITag3" Type="DI" Init="0" Address="3" />
     <Tag Name="DOTag0" Type="DO" Init="0" Address="0" />
     <Tag Name="DOTag1" Type="DO" Init="0" Address="1" />
     <Tag Name="DOTag2" Type="DO" Init="0" Address="2" />
     <Tag Name="DOTag3" Type="DO" Init="0" Address="3" />
</OPCSrvTags>
```


For making 3G modem off and on in your logic , you need to use SYS.3GModemON Signal .

SYS.3GModemSignalLevel is showing status of 3G Network . When 3G Network is connected and RTU has WAN IP , then this signal is 100 , otherwise it is 0 .

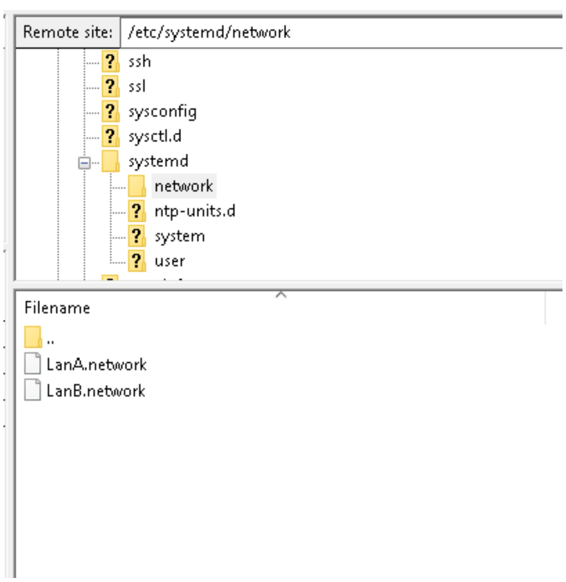
For setting APN name in Uno1252G you should edit /etc/chatscripts/pap file as following :

```
# To use it, add something like this to your /etc/ppp/peers/ file:
#
# connect "/usr/sbin/chat -v -f /etc/chatscripts/pap -T PHONE-NUMBER"
# user YOUR-USERNAME-IN-PAP-SECRETS
# noauth

# Uncomment the following line to see the connect speed.
# It will be logged to stderr or to the file specified with the -r chat option.
#REPORT      CONNECT

ABORT        BUSY
ABORT        VOICE
ABORT        "NO CARRIER"
ABORT        "NO DIALTONE"
ABORT        "NO DIAL TONE"
""       ATZ
OK ATX3
OK AT+CGDCONT=1,"IP","rightel",,0,0
OK ATD*99#
CONNECT      ""
```

Change “rightel” to your APN name.

Setting LAN Parameters:

For setting IP address of LanA and LanB you need to edit /etc/system/network/LanA.network and LanB.network files .



In following sample LanA is set to 192.168.1.60

```
[Match]
Name=enp0s20f6

[Network]

Address=192.168.1.60/24
```

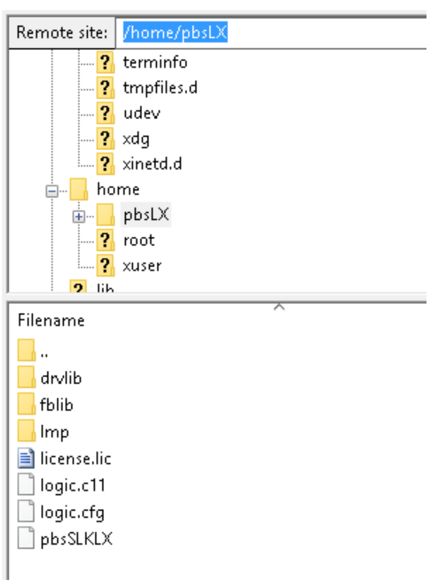
UNO1252G has 3 User defined LED that are used internally in pbsSoftLogic kernel .

PL1 : Run LED . When pbsSLKLX is loading , PL1 is start to blink .

PL2 : When 3G Modem is connected to network and Uno1252G received IP address from WAN , it will set to True.

PL3 : Not Used

As other Linux based RTUs, runtime kernel of pbsSoftLogic is located at /home/pbsLX directory of UNO1252G .

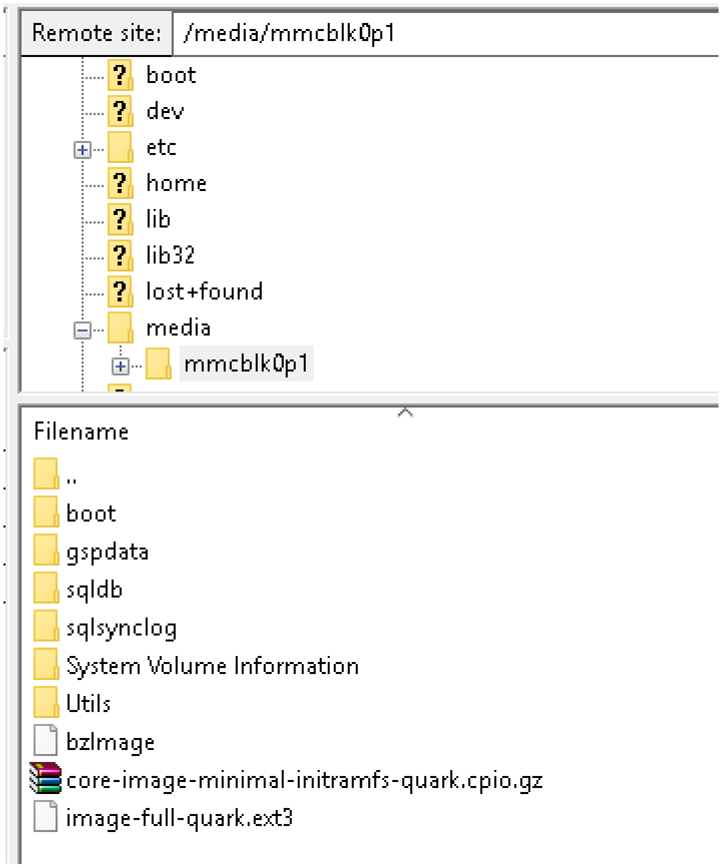


For UNO1252G you need to get License from supplier for proper operation of Kernel . Without License pbsSLKLX is running for 30 min for demonstration.

For enabling License please refer to chapter 11.

We did some modification in UNO1252G Yocto linux for using COM2 as normal Serial port . In original OS of Uno1252 , COM2 is used as Console Serial Port . So please always use OS image that is modified by pbsControl to use COM2 as standard Serial port.

UNO1252 SD card Address for archiving data by GSP or SQLite driver : /media/mmcblk0p1



22 – AMS MDL1000 , IDL2000 and RTU 100 Configuration.

23 –MAPCSR Configuration.

MAPCSR is RTU platform from MAPNA –MECO and pbsControl Companies.

MAPCS is MAPNA DCS Platform. We used same MAPCS Hardware and powered it by pbsSoftLogic RTU Configuration and programming Environment to make a full feature RTU system.

MPACSR has following features:

- Modular RTU with high performance CAN protocol in backplane for Communication between CPUs and IO Modules
- Hot Swap IO Modules
- Supports 1 GB of RAM , 8 GB of Flash , 900 Mhz CPU
- 1 x Ethernet Port , 1 xRS232 , 1XRS485 port
- Max 64 Slots of IO Module supported
- Full Redundant RTU , CPU , Power supply and communication
- Supports Standard Function Block and Lua Scripting for easy programming
- Supports Modbus RTU/TCP Master /Slave , IEC101/104 Slave , DNP3 Slave , OPC UA Server , SQLite for local Data archiving with Automatic Synchronization with SQL Server at Master SCADA, GSP Client and S7-Connect Protocols .
- Offline Simulation of Logic and Logic Monitoring facility
- User Defined Function Block by Lua Scripting
- Supports SDK for developing custom communication driver
- Supports High Level process Function Blocks for easy DCS style programming
- Embedded Linux OS

MAPCSR can be used in following projects:

- Water and Waste Water Pump stations as PLC/RTU
- Oil and Gas Pipe Line ScADA systems as RTU
- Water and Waste Water Treatment plant as RTU/PLC
- Power plants , Petrochemicals and refineries as utility control system

Hardware structure

MAPCSR is using backplane technology for communication between IO Modules and Main CPUs.

MAPCSR Backplane has two parts: upper and lower parts

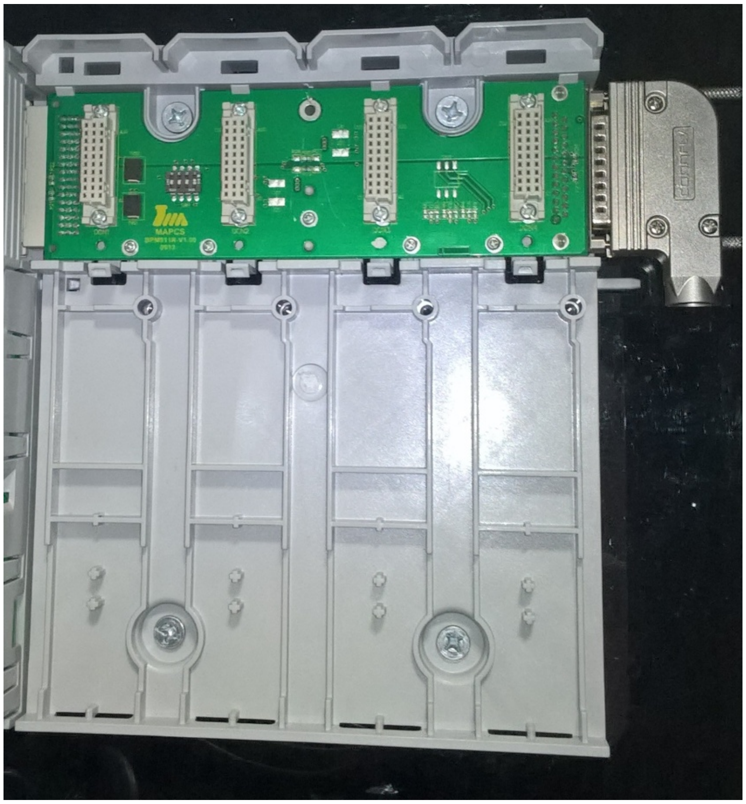
At upper part, IO module will install and in lower part field cable will connect.

You can easily changed failed IO module without doing any modification in wires and field connections.

All IO Modules are hot swap. You can remove IO module and insert it again when system has power. It will not affect other IO modules operation.

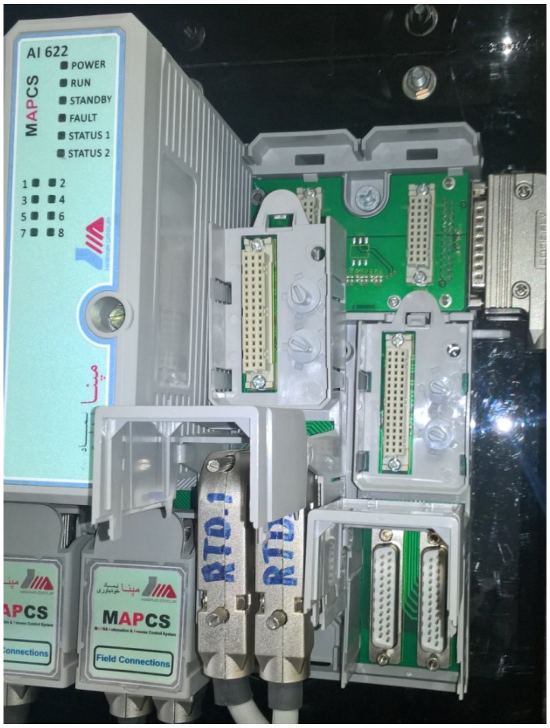
MAPCSR Backplane

MAPCSR Backplane has two parts: Upper part



And lower part:

Lower backplane is used for field connection. As it clear from above figure, Field wires will connect through two DSUB25 pins to IO Modules.



RTU 450 Main CPU

RTU 450 is main CPU of MAPCSR RTU. RTU450 has following specifications:

- 900 MhZ ARM Cortex A7 CPU
- 1 GB RAM
- 6 GB Flash
- 1xEthernet 10/100 Port
- 1xRS232 Port
- 1xRS485 Port
- Embedded Linux OS
- LEDs: Power, Run, Fault and Serial Port.
- Operating temperature : -20 to +60 Deg
- Powered by pbsSoftLogic Runtime Kernel

Digital IO Modules

Modules / Specifications	DI 530	DO 580	DO 571
Label	DI530	DO580	DO571
Number of channels	32	32	16
Output type	----------	High side switch	High side switch
Input type	Sink	----------	----------
Input Impedance	> 2KΩ	----------	----------
Rated supply voltage	24V DC	24V DC	24V DC
Permitted supply voltage range	18V DC to 30V DC	18V DC to 30V DC	18V DC to 30V DC
Minimum Output voltage	----------	> Vs - 0.8V (at 1 signal)	> Vs - 0.8V
Maximum Output current	----------	0.5A (at 1 signal)	0.4A
Maximum leakage current	----------	0.5mA @ 30V DC	0.5mA @ 30V DC
Maximum Output frequency (Resistive loads)	----------	100Hz	100Hz
Maximum Output frequency (Inductive loads)	----------	1 Hz	1 Hz
Maximum Output frequency (Lamp loads)	----------	100Hz	100Hz
Short circuit protection	----------	Yes (Electronic)	Yes (Electronic)

Short circuit peak current	----------	1.5A	1.4A
Voltage induced on current interruption limited to	----------	Vs ± 48V	Vs ± 48V
Isolation type (to backplane bus)	Optocoupler	Optocoupler	Opto-coupler
Isolated in groups of	8	8	8
Isolation between bus and analog section	2500V DC	2500V DC	2500V DC
Power consumption (from backplane bus)	Maximum : 2W	Maximum : 2W	Maximum : 2W
	Typical : 0.6W	Typical : 0.6W	Typical : 1.3W
Operating temperature	-40˚C to +85˚C	-40˚C to +85˚C	-40˚C to +85˚C
Storage temperature	-40˚C to +85˚C	-40˚C to +85˚C	-40˚C to +85˚C
Relative humidity	5% to 95%	5% to 95%	5% to 95%
Reference Standard	IEC 61131-2	IEC 61131-2	IEC 61131-2
Terminal	BPL 922S , BPL 921D	BPL 922S , BPL 921D	BPL 922S , BPL 921D
Diagnostics	----------	Group Short-Circuit, Missing Field Power, Board Temperature, Internal Hardware Error	Short-Circuit, Wire Break, Missing Field Power, Internal Hardware Error, Board Temperature
Rated Input voltage value	24V DC	----------	----------
Maximum permissible input voltage	±40V DC	----------	----------
Input high level (1)	13V DC to 30V DC	----------	----------
Input low level (0)	-30V DC to +5V DC	----------	----------
Maximum Input frequency	300Hz	----------	----------
Typical Input current (at 1 signal)	4mA @ 24V DC	----------	----------
Maximum Input Current	12mA @ 40V DC	----------	----------
Maximum permissible quiescent current	1mA	----------	----------

Analog IO modules

Modules / Specifications	AI 622	AI 623	AI 621	AO 672	AO 673
Label	AI622	AI623	AI621	AO672	AO673
Number of channels	8	8	8	8	8
Current Input/ Output Range	Input Range: 0/4-20mA	Input Range: 0/4-20mA HART Compatible	Input Range -Thermocouple: B, E, J, K, N, R, S, T Input Range - RTD: PT100, PT200, PT500, PT1000	Output Range-Current: 0/4-20mA Maximum Output current: 21.8 mA	Output Range-Current: 0/4-20mA HART Compatible Maximum Output current: 21.8 mA
Diagnostics	Wire Break, Input Short Circuit, Overflow, Underflow, Missing Field Power, Missing Analog Power, Internal Hardware Error, Board Temperature	Wire Break, Input Short Circuit, Overflow, Underflow, Missing Field Power, Missing Analog Power, Internal Hardware Error, Board Temperature	Wire Break, Input Short Circuit, Overflow, Underflow, Missing Field Power, Missing Analog Power, Internal Hardware Error, Board Temperature	Missing Analog Power, Missing Field Power, Wire Break, Internal Hardware Error, Board Temperature	Missing Analog Power, Missing Field Power, Wire Break, Internal Hardware Error, Board Temperature
Resolution	16 bits	16 bits	16 bits	14 bits	14 bits
Accuracy	±0.1%	±0.1%	± 1°C	±0.1%	±0.1%
Accuracy over temperature range	0.15% max	0.15% max	0.15% max	0.25% maximum	0.25% maximum
Nonlinearity	0.002%	0.002%	0.00%	-1/+2 LSB max	-1/+2 LSB max
Calibration	Internal	Internal	Internal	-----------	-----------
Sample Rate	20sps (per channel)	20sps (per channel)	About 10sps (per channel)		
Noise suppression for noise frequency	50/60 Hz	50/60 Hz	50/60 Hz	-----------	-----------

Isolation between bus and analog section	At least 1000V DC	At least 1000V DC	At least 1000V DC	----------	----------
Maximum permissible input voltage range	+12V DC to -5V DC	+12V DC to -5V DC	----------	----------	----------
Power consumption (from backplane bus)	Max: 2W Typical : 1.4W	Max: 2W Typical : 1.4W	Max : 2W Typical : 1.4W	Maximum : 2W Typical : 1.4W	Maximum : 2W Typical : 1.4W
Operating temperature	-40˚C to +85˚C	-40˚C to +85˚C	-40˚C to +85˚C	-40˚C to +85˚C	-40˚C to +85˚C
Storage temperature	-40˚C to +85˚C	-40˚C to +85˚C	-40˚C to +85˚C	-40˚C to +85˚C	-40˚C to +85˚C
Relative humidity	5% to 95%	5% to 95%	5% to 95%	5% to 95%	5% to 95%
Reference Standard	IEC 61131-2	IEC 61131-2	IEC 61131-2	IEC 61131-2	IEC 61131-2
Rated supply voltage	24V DC	24V DC	----------	24V DC	24V DC
Permitted supply voltage range	18V DC to 30V DC	18V DC to 30V DC	----------	18V DC to 30V DC	18V DC to 30V DC
Connection types	2-wire (loop powered), 4-wire	2-wire (loop powered), 4-wire	2-wire, 3-wire, 4-wire	----------	----------
Input impedance	----------	----------	> 20MΩ	----------	----------
Thermocouple Cold Junction Compensation	----------	----------	Internal/External	----------	----------
Settling time	----------	----------	----------	5ms	5ms
Current output Maximum open circuit voltage	----------	----------	----------	±14V	±14V
Minimum load impedance for voltage outputs	----------	----------	----------	500Ω	500Ω
Maximum load impedance for current outputs	----------	----------	----------	600Ω	600Ω
Maximum load impedance for capacitive loads	----------	----------	----------	1µF	1µF
Maximum load impedance for inductive loads	----------	----------	----------	10mH	10mH

Power supply Redundancy

At left side of RTU backplane, there is a DSUB25 Connector for connecting Redundant Power connection.

By help of this connector you can connect two power supplies to RTU. All RTU power, Field Power is also supplied by this Redundant Power input.

Software Configuration

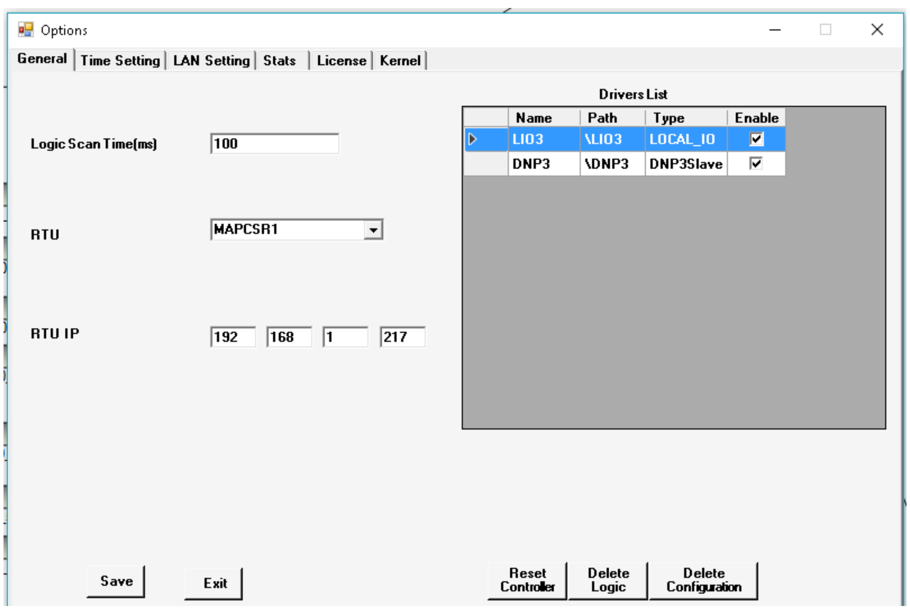
For MAPCSR Configuration you should use pbsSoftLogic Platform. For detail information about pbsSoftLogic please refer to www.pbscontrol.com

pbsSoftLogic Engineering is Free and you can download it from Web Site .

You can do following tasks with pbsSoftLogic Engineering:

- Protocol configuration
- Logic development by Standard Function Block
- Defining User FB by Lua Scripting
- Offline Simulation of Logic
- Transferring compiled logic to RTU and monitor logic
- Force Signals and test Logic when it is running on RTU

Define a new pbsSoftLogic project and in setting page, select MAPCSR1 as RTU:



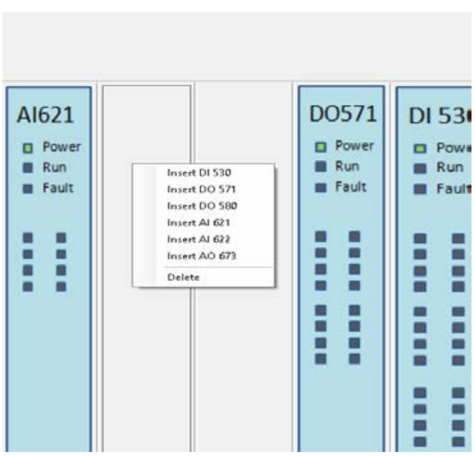
Right click in Driver List and add a new Local_IO

Right Click in new Local_IO and select Edit. MAPCSR configuration utility will open.

You can see select IO modules with this utility.

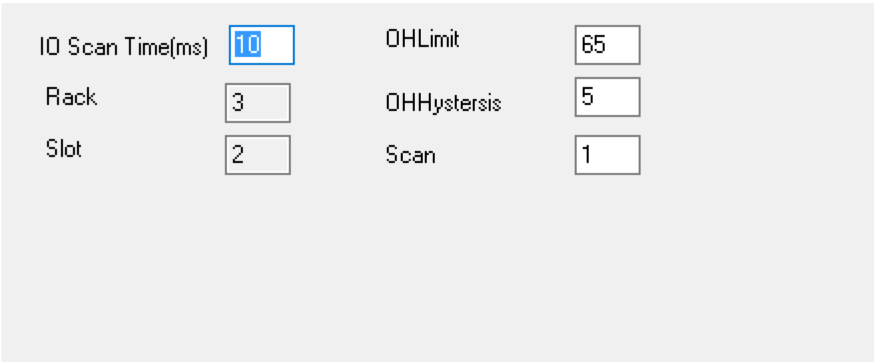
There are 16 Slot for inserting IO modules. You can define up to 64 IO Modules in MAPCS but in MAPCSR we reduce it to 16. But it is possible to add more IO Modules in MAPCSR.

Click on a slot and then right click on it. You can see following menu:



You can insert new IO module or delete it.

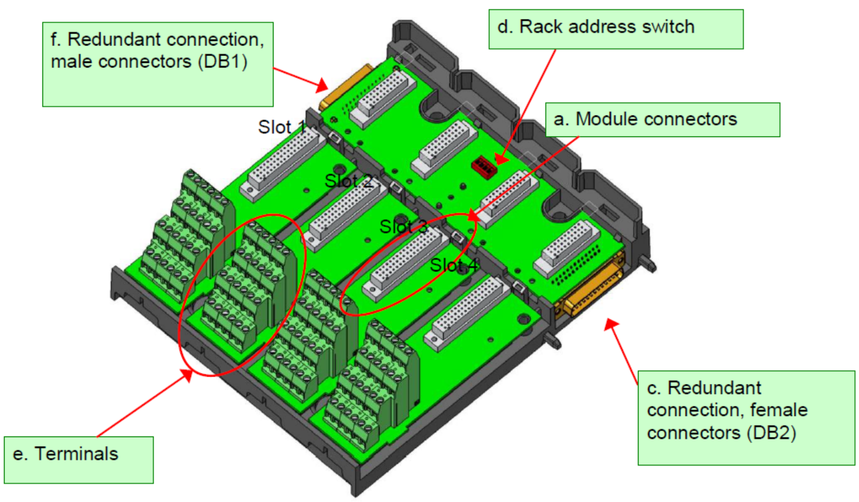
Following items are common for all IO Modules :



IO Scan Time (msec) : is scan time of Slots in driver . if this parameter is 10 msec then all defined IO will scan every 10 msec .

Rack and Slot is read only and handle by Utility. It is Rack Number and Slot number in MAPCS system.

MAPCS Backplane has a Rack switch for setting Rack Address .

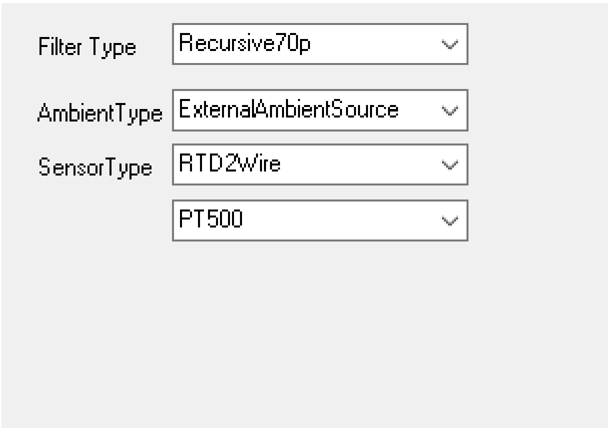


For first backplane with CPU, you need to set rack to 0.

Each backplane has 4 slots. For first backplane, first two slots will use for CPU, so first slot for IO modules has rack 0 and slot 2. Slot index is start from 0.

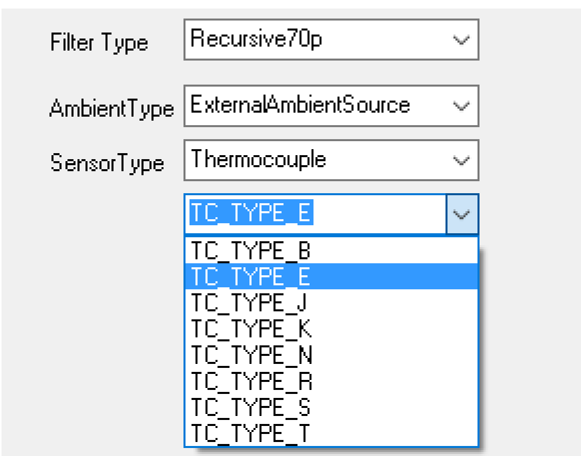
Backplanes from left to right should have rack number 0 ,1,2,3,4

When you click on a AI621, then you can set following parameters too:

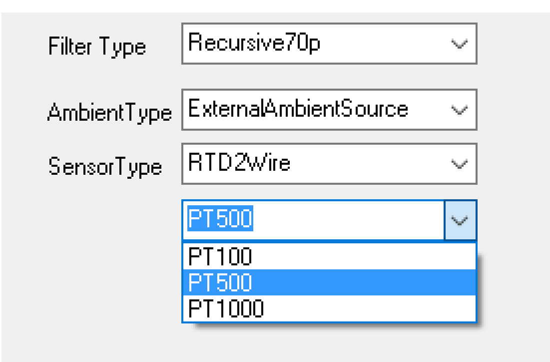


AI621 is Thermocouple and RTD Module. You can set Filter Type, Ambient Temperature sensor Type, sensor type and sensor name.

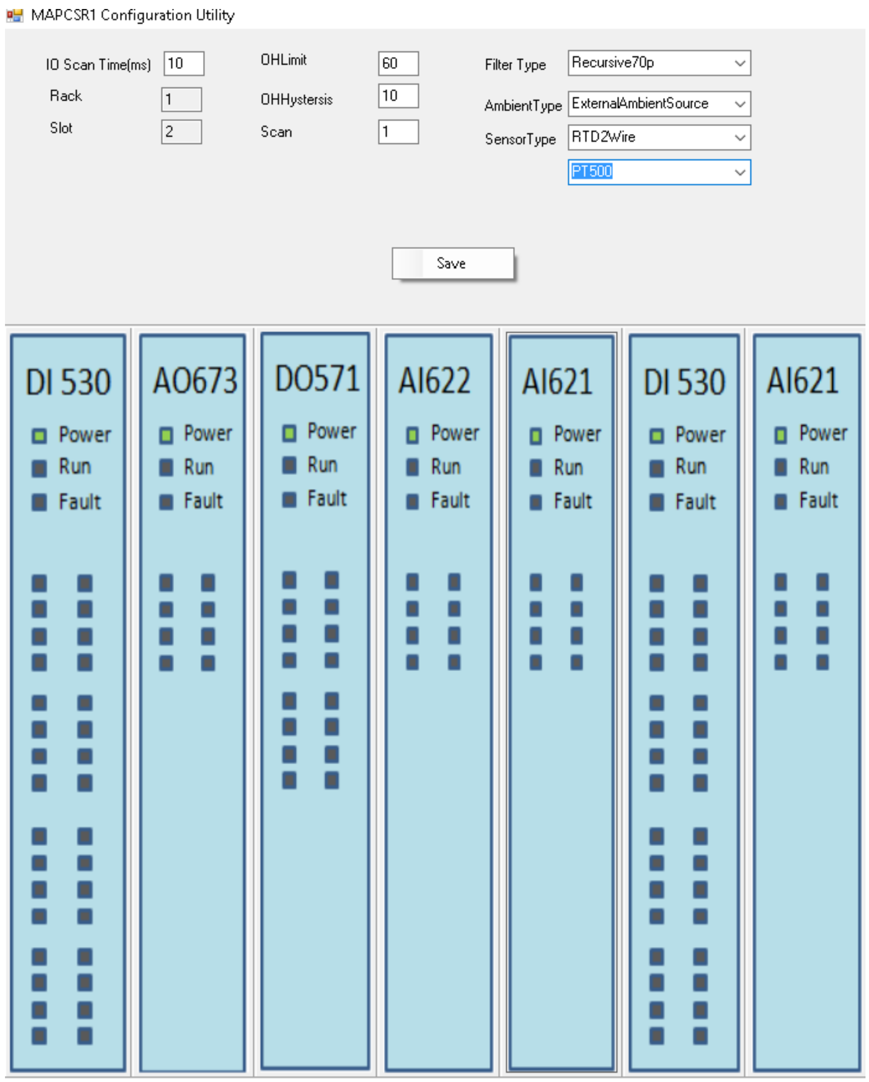
When select Thermocouple in Sensor Type, and then parameters will change as following:



When select RTD In sensor Type, parameters will change as following:

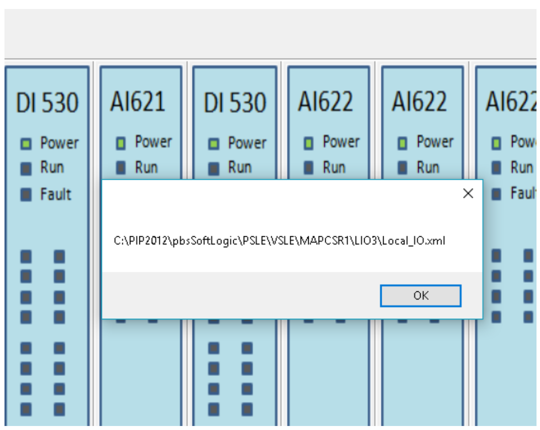


When you finish configuration of all IO modules, save configuration by right click on parameters area.



Local_IO.xml file will save In project path in local_Io directory name.

Utility will message you full path of Local_IO.xml file .



If you open Local_IO.xml file in an editor you can see MAPCSR Modules configuration in xml format :


```xml
        <Tag Name="DI_B0_S0_22" Address="22" />
        <Tag Name="DI_B0_S0_23" Address="23" />
        <Tag Name="DI_B0_S0_24" Address="24" />
        <Tag Name="DI_B0_S0_25" Address="25" />
        <Tag Name="DI_B0_S0_26" Address="26" />
        <Tag Name="DI_B0_S0_27" Address="27" />
        <Tag Name="DI_B0_S0_28" Address="28" />
        <Tag Name="DI_B0_S0_29" Address="29" />
        <Tag Name="DI_B0_S0_30" Address="30" />
        <Tag Name="DI_B0_S0_31" Address="31" />
    </Slot>
    <Slot Base="0" SlotIndex="3" Type="AO673" Scan="1" OHLimit="65" OHHysteresis="5" FilterType="0" ambientType="0" sensorType="0">
        <Tag Name="AO_B0_S1_0" Address="0" />
        <Tag Name="AO_B0_S1_1" Address="1" />
        <Tag Name="AO_B0_S1_2" Address="2" />
        <Tag Name="AO_B0_S1_3" Address="3" />
        <Tag Name="AO_B0_S1_4" Address="4" />
        <Tag Name="AO_B0_S1_5" Address="5" />
        <Tag Name="AO_B0_S1_6" Address="6" />
        <Tag Name="AO_B0_S1_7" Address="7" />
    </Slot>
    <Slot Base="1" SlotIndex="0" Type="DO571" Scan="1" OHLimit="65" OHHysteresis="5" FilterType="0" ambientType="0" sensorType="0">
        <Tag Name="DO_B1_S0_0" Address="0" />
        <Tag Name="DO_B1_S0_1" Address="1" />
        <Tag Name="DO_B1_S0_2" Address="2" />
        <Tag Name="DO_B1_S0_3" Address="3" />
        <Tag Name="DO_B1_S0_4" Address="4" />
        <Tag Name="DO_B1_S0_5" Address="5" />
```


For each IO module there is a Slot Tag with detail parameters. For each Slot Tag, there are Tags with Name and address parameters.

Address is channel number in IO module (do not change them) but you can change Name of signal based on your process specification. Always use unique name for a signal.

When you change signal name, you can use MPACSR In pbsSoftLogic like other RTUs. For detail please refer to pbsSoftLogic User Manual to configure all other protocols and writing Logic.

24 – Standard Function Blocks Definition.

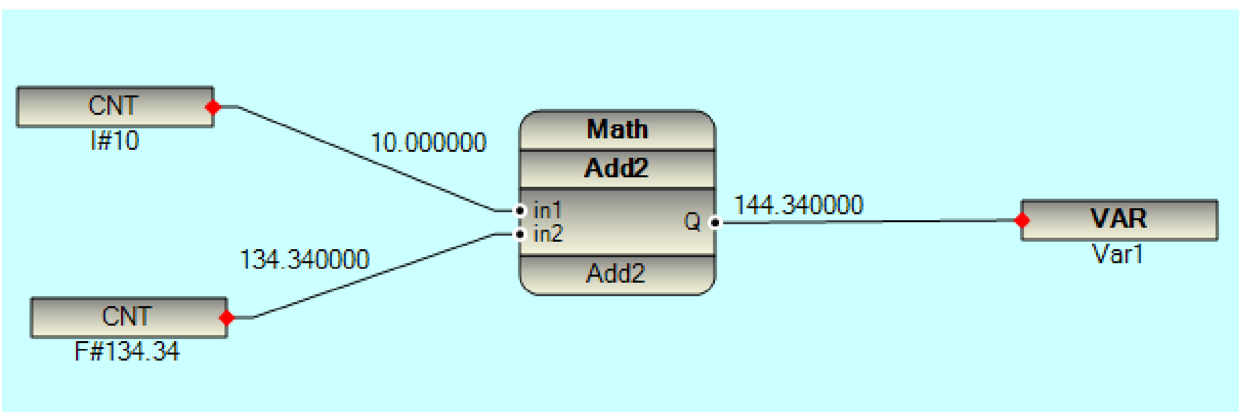
pbsSoftLogic has many Ready and tested Function Block for Easy and Fast Programming .

There are following groups in pbsSoftLogic:

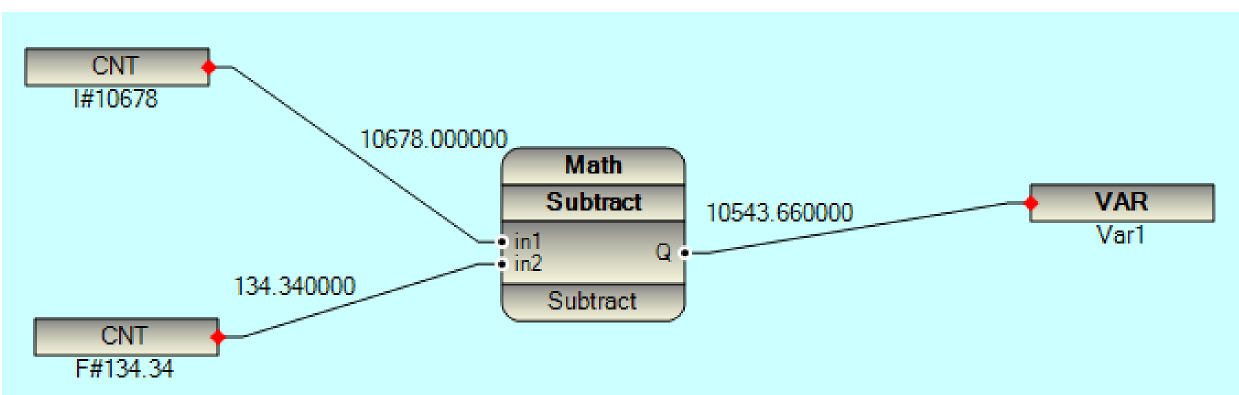
- Math : Mathematics Function Groups
- Timers: Timer Function Blocks and Signal Generators
- Counters : Counters Function Blocks
- Logical : Logical Function Block Groups
- Process: High Level Process Function Blocks
- IEC11313: Standard Function Blocks based on IEC1131-3 standard
- Scheduling : Daily , Weekly , Monthly and Yearly Scheduling Function Blocks

Math Group:

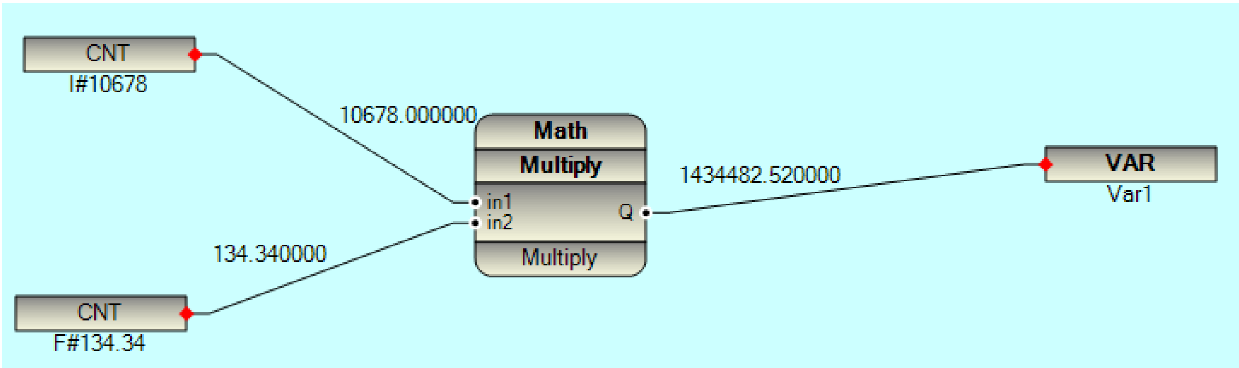
Add2 : Add two numbers with different types .



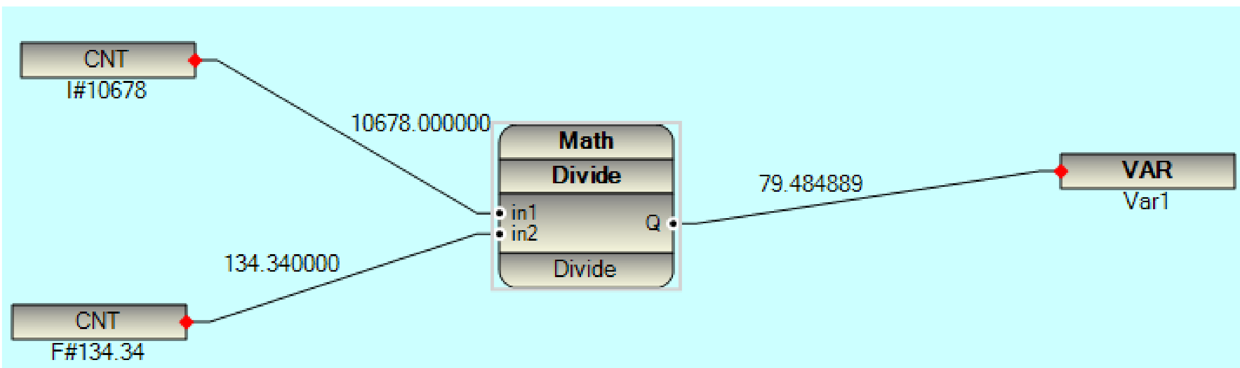
Subtract : Subtract two numbers with different types .



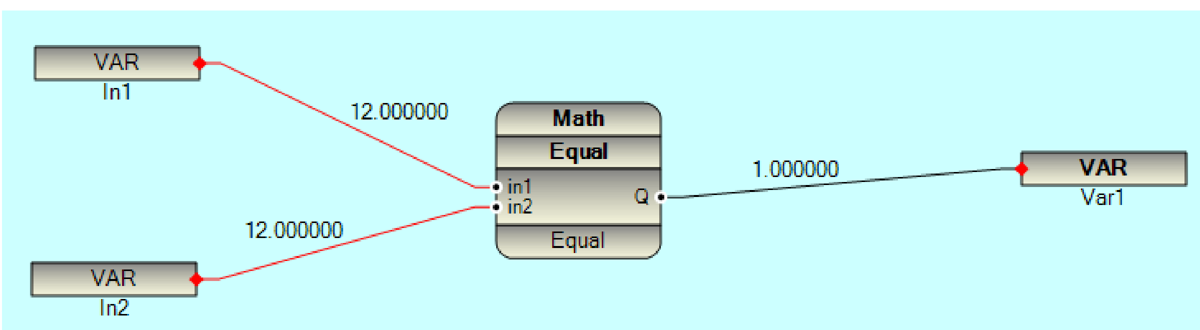
Multiply : Multiply two numbers with different types .

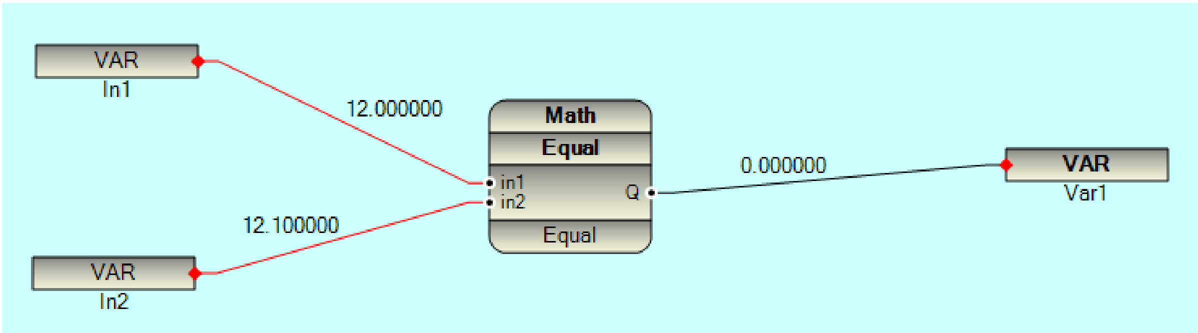


Divide : Divide two numbers with different types .

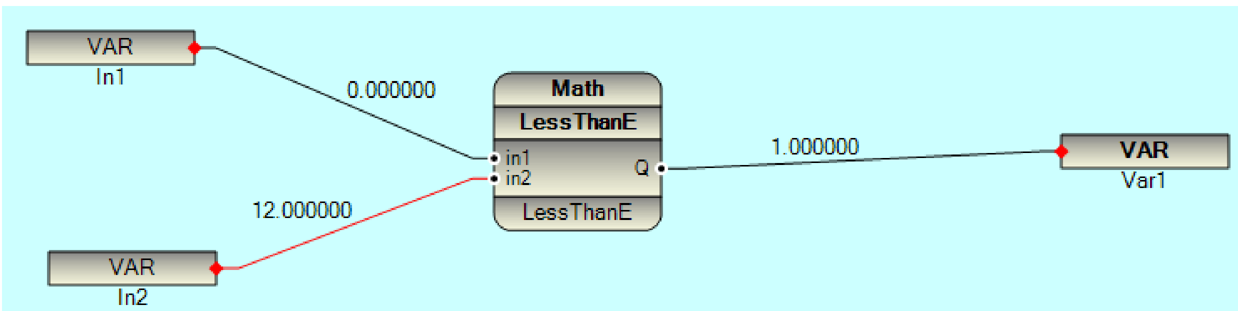


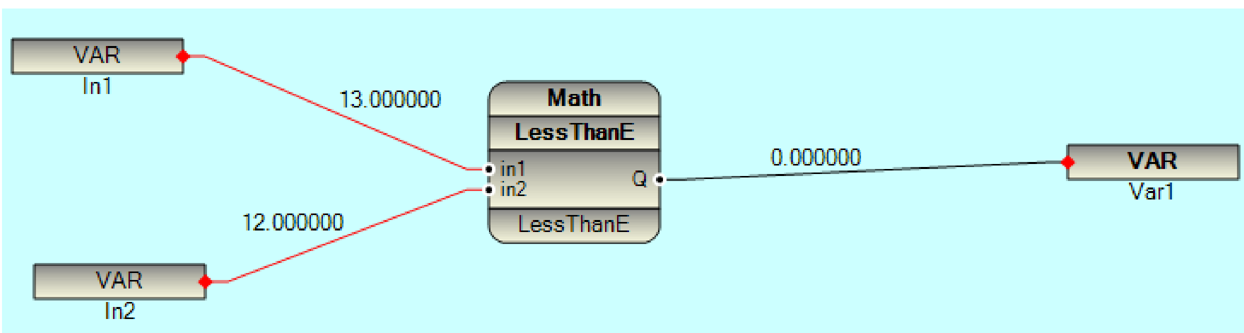
Equal : If In1 is Equal to In2 , Output is 1 , otherwise Output is 0



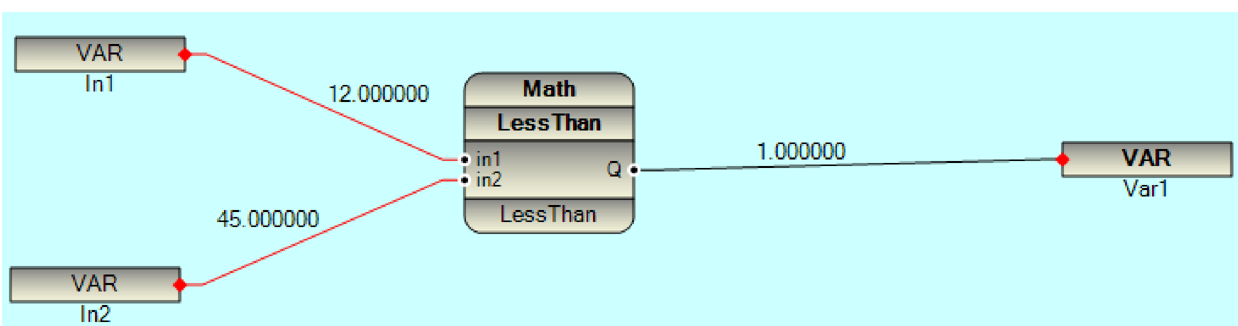


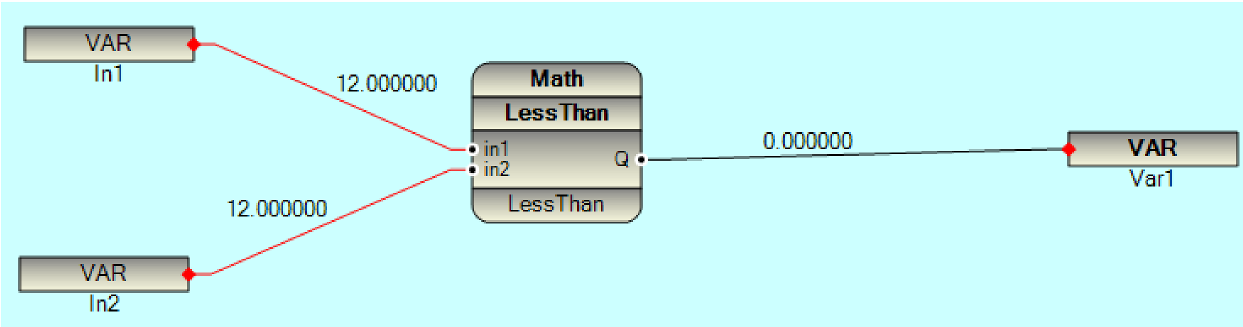
LessThanE : If In1 is Less Than or Equal to In2 , Output is 1 , otherwise Output is 0



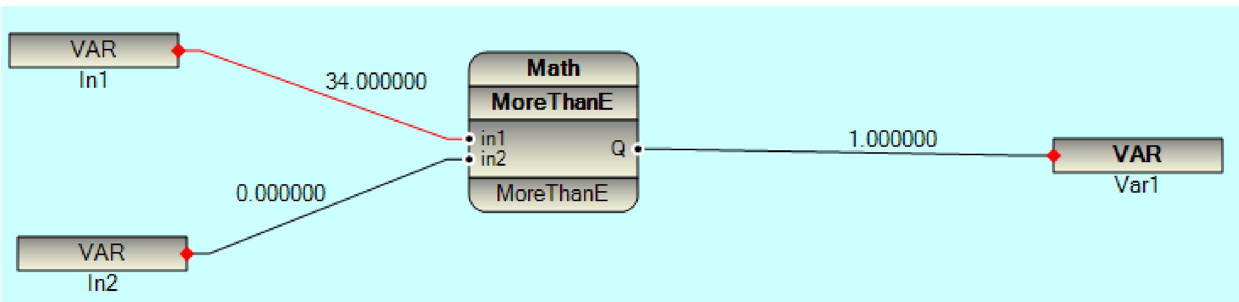


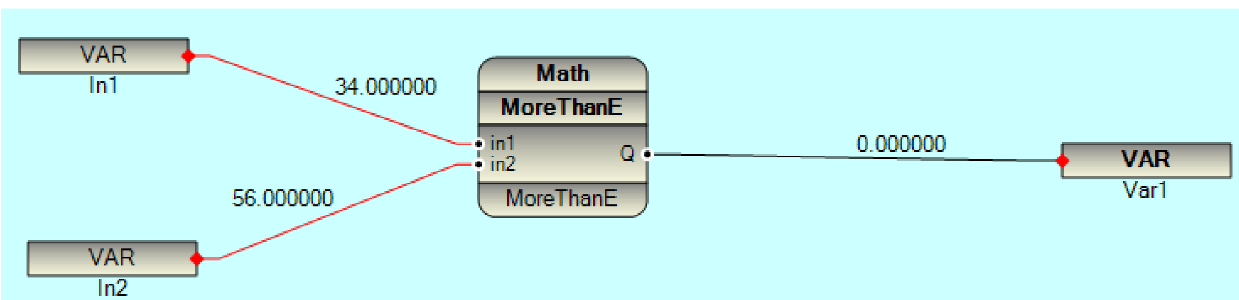
LessThan : If In1 is Less Than to In2 , Output is 1 , otherwise Output is 0



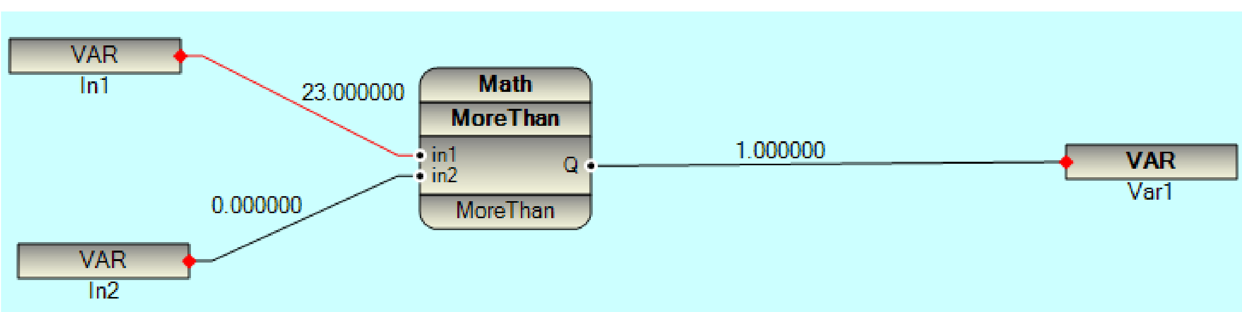


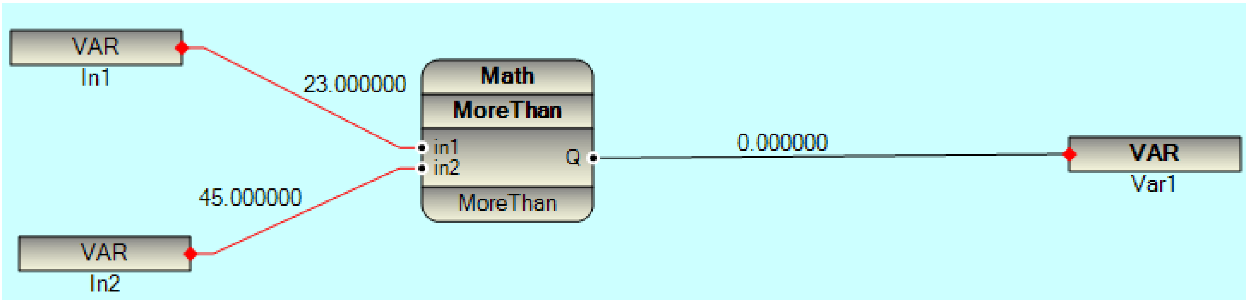
MoreThanE : If In1 is More Than or Equal to In2 , Output is 1 , otherwise Output is 0



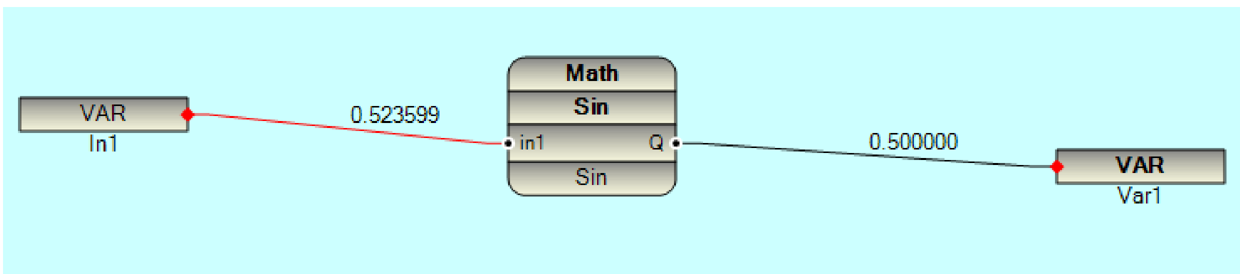


MoreThan : If In1 is More Than In2 , Output is 1 , otherwise Output is 0

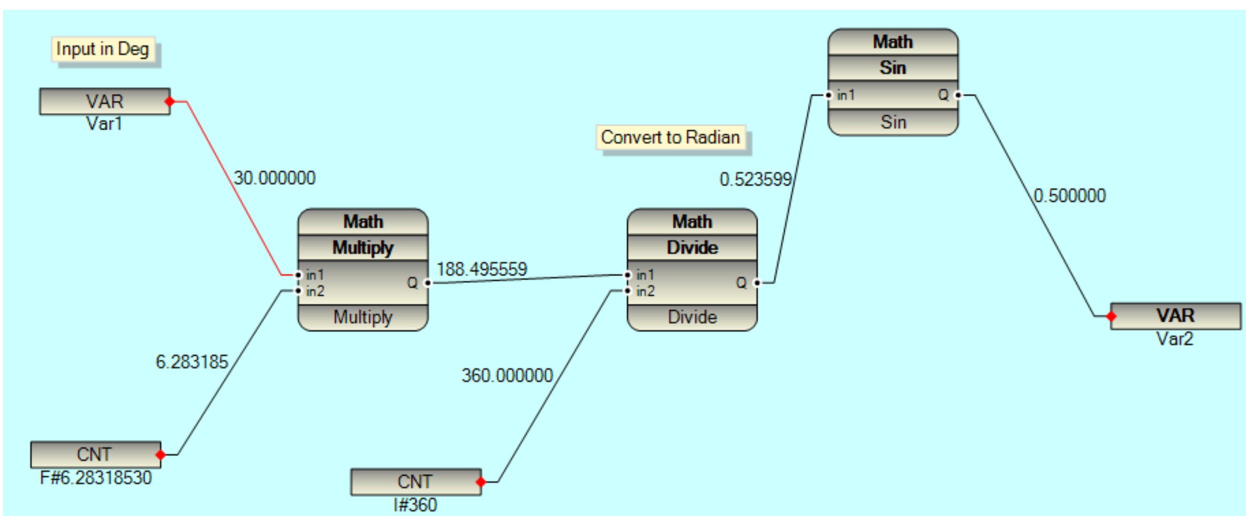




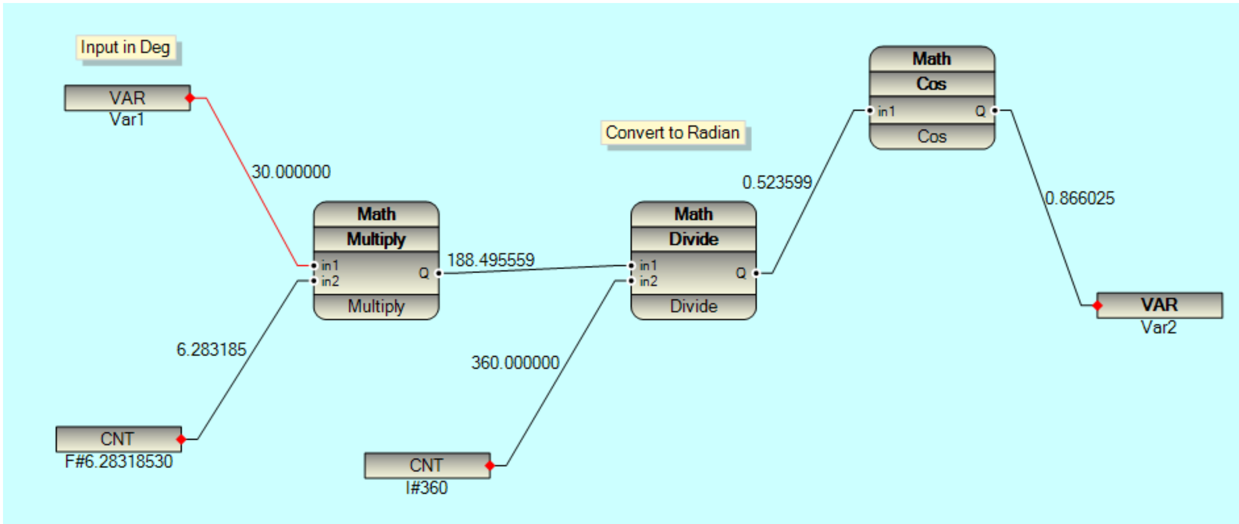
Sin : Sin Function returns sine of In1 ,where In is given in Radians .



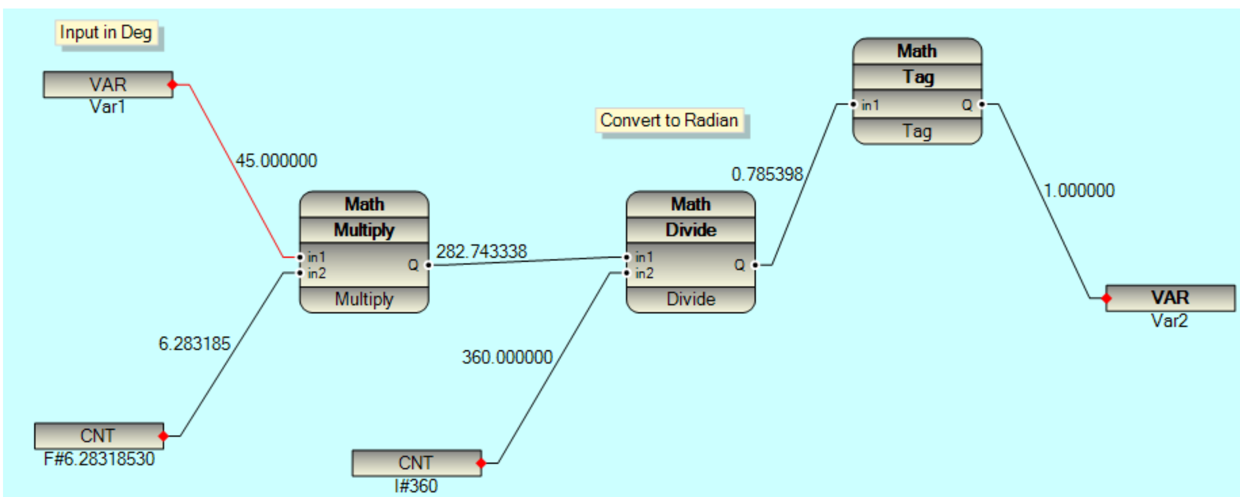
In1 should be in radians.



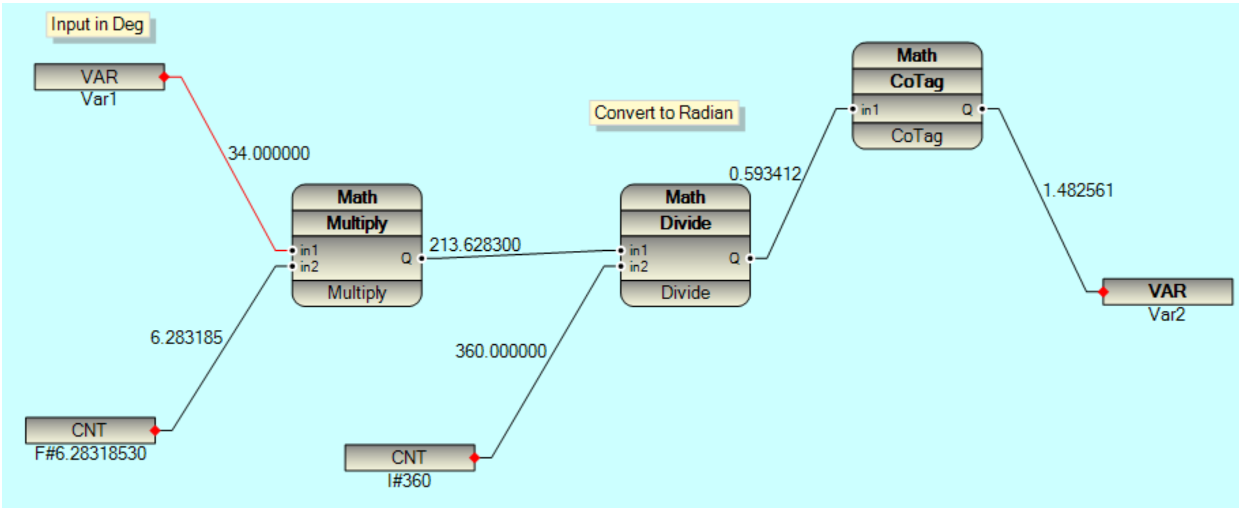
Cos : Cos Function returns Cosine of In1 ,where In is given in Radians .



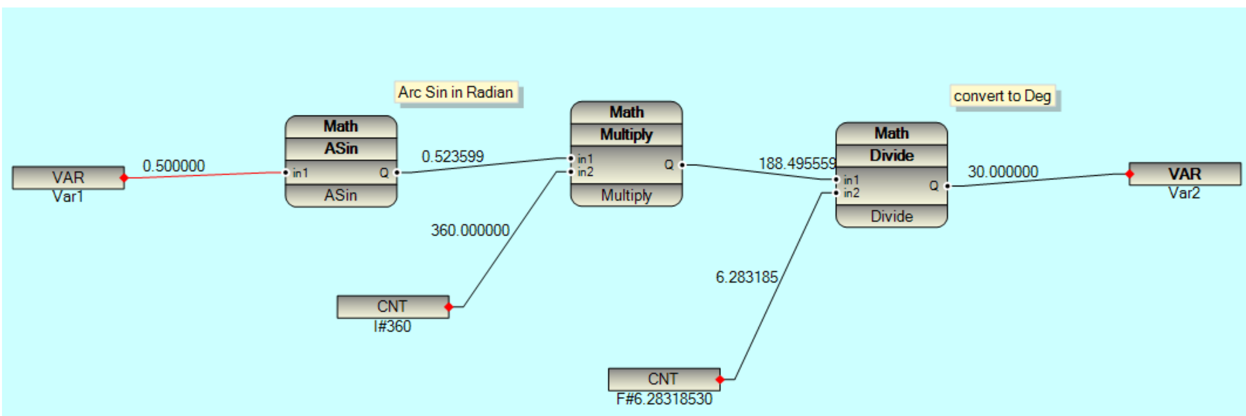
Tag : Tag Function returns Tangent of In1 ,where In is given in Radians .



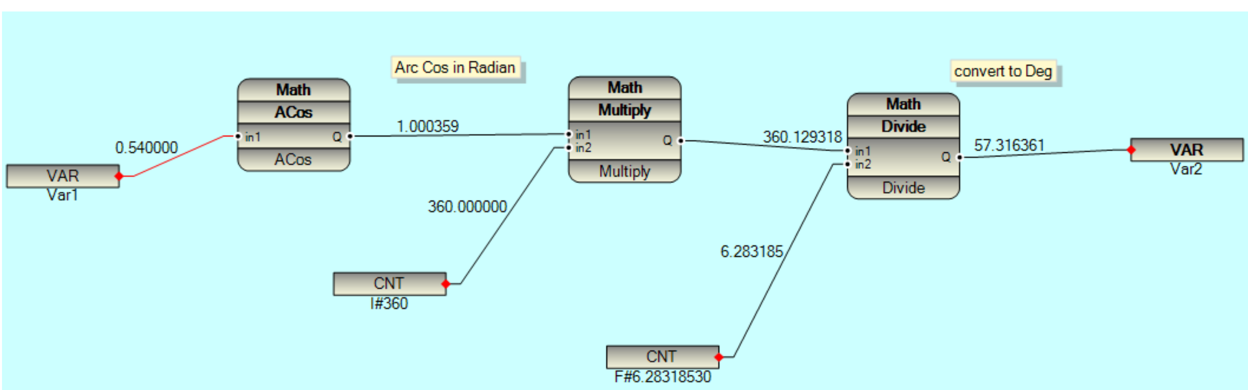
CoTag : CoTag Function returns reverse of Tangent of In1 ,where In is given in Radians .



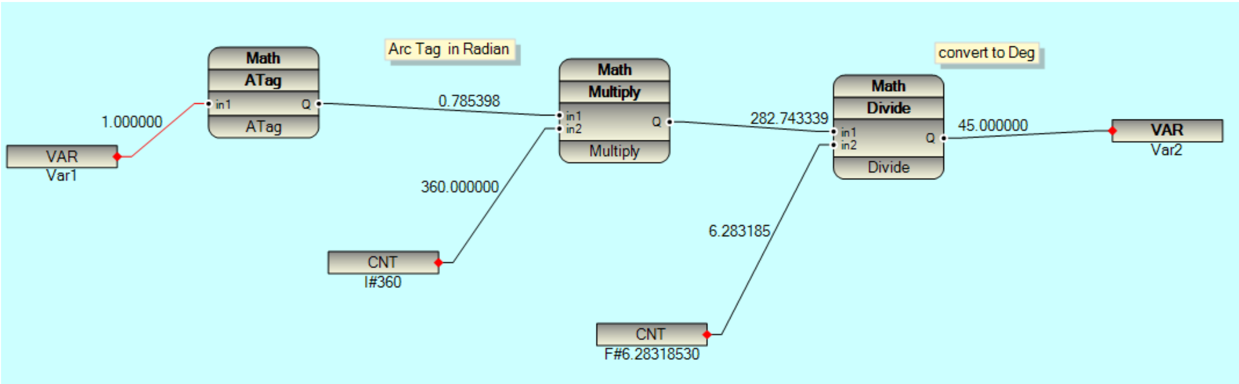
ASin : ASin Function returns Arc Sin of In1 ,where In is given in Radians .



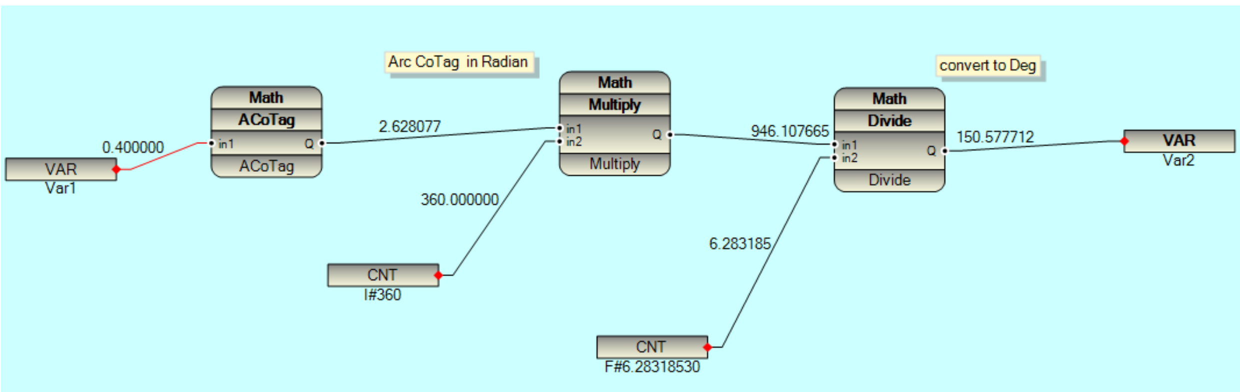
ACos : ACos Function returns Arc Cosine of In1 ,where In is given in Radians .



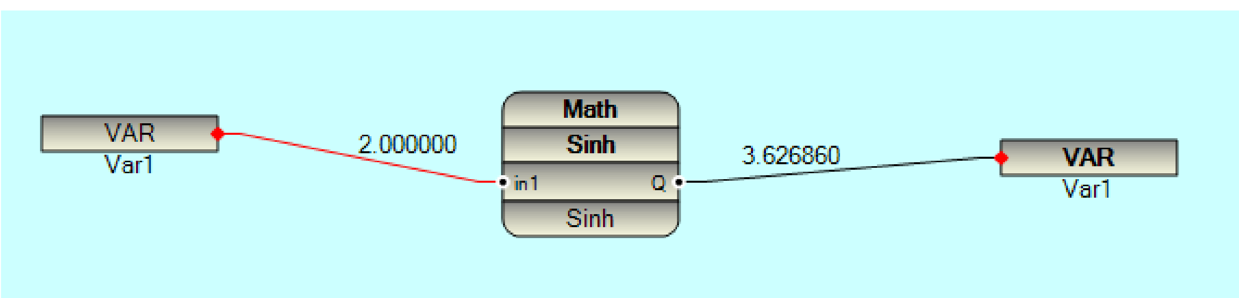
ATag : ATag Function returns Arc Tangent of In1 ,where In is given in Radians .



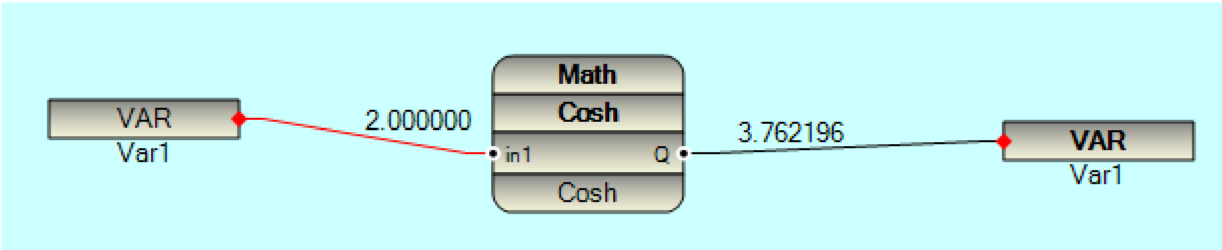
ACoTag : ACoTag Function returns reversed of Arc Tangent of In1 ,where In is given in Radians .



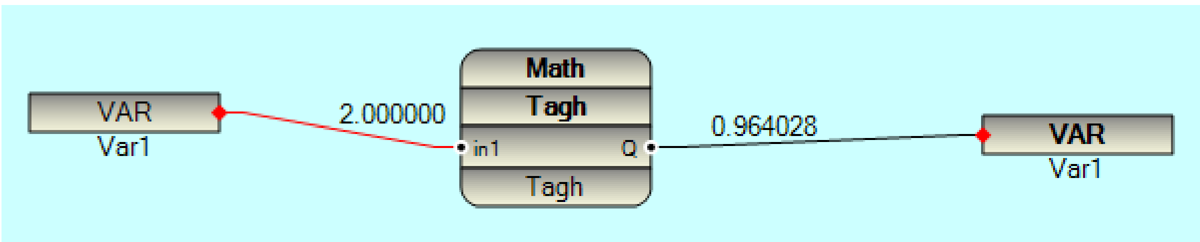
SinH : The **sinh()** function returns the hyperbolic sine of *x*, which is defined mathematically as (exp(x) - exp(-x)) / 2.



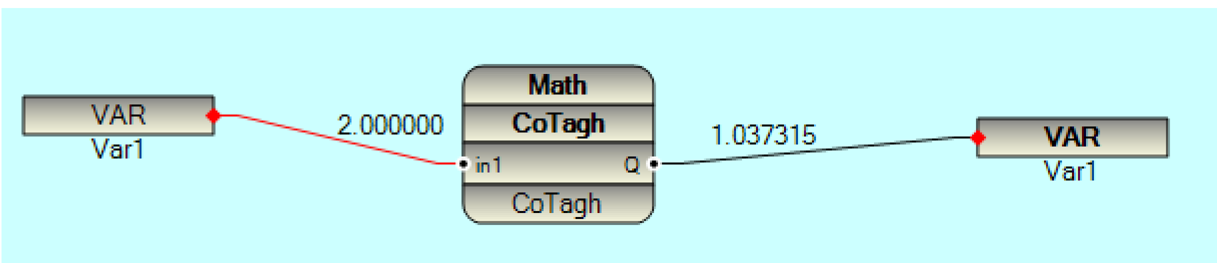
CosH : The **cosh()** function returns the hyperbolic cosine of *x*, which is defined mathematically as (exp(x) + exp(-x)) / 2.



TagH :The **tanh()** function returns the hyperbolic tangent of *x*, which is defined mathematically as sinh(x) / cosh(x).



CoTagH :The CoTagH function returns the hyperbolic cotangent of *x*, which is defined mathematically as cosh(x)/ sinh(x).

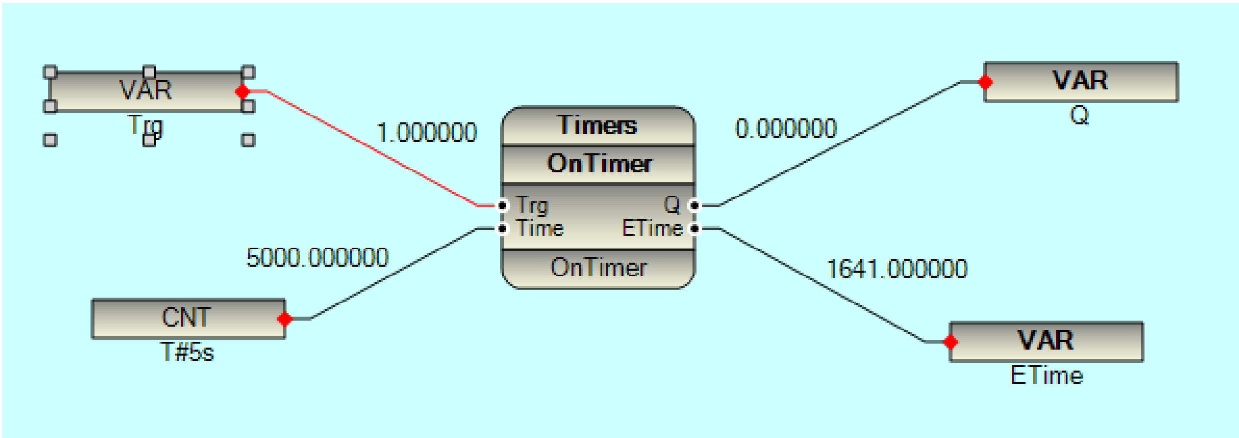


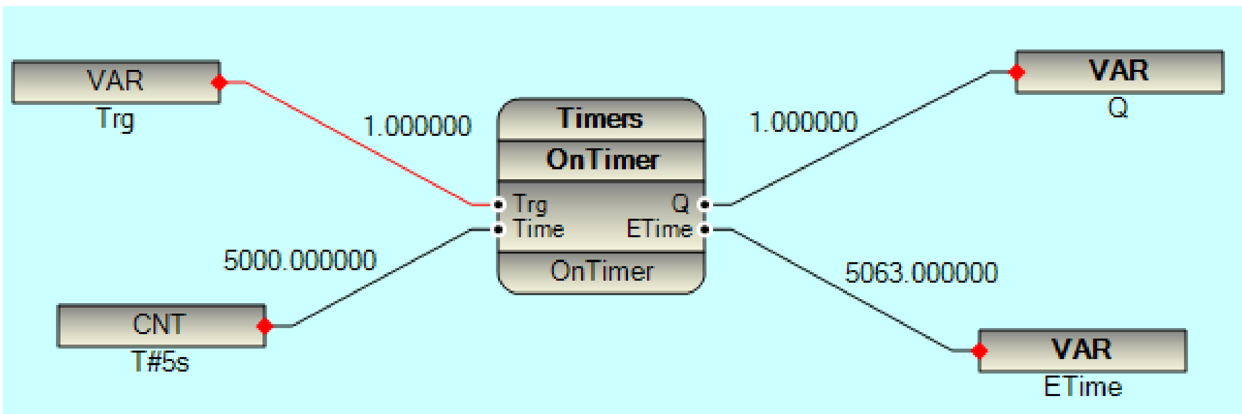
ASinH :The **asinh()** function calculates the inverse hyperbolic sine of *x*; that is the value whose hyperbolic sine is *x*.

Timer Group:

OnTimer : When Trg Input Change from 0 to 1 , After passing Time Input (in msec) , Output Q will changed to 1 .

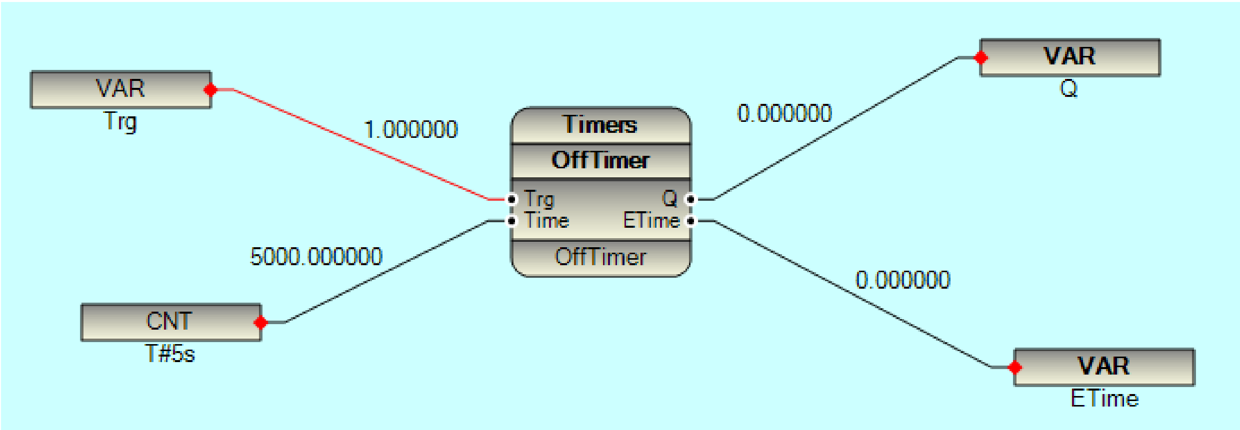
Etime Output Shows Time passed in Msec .

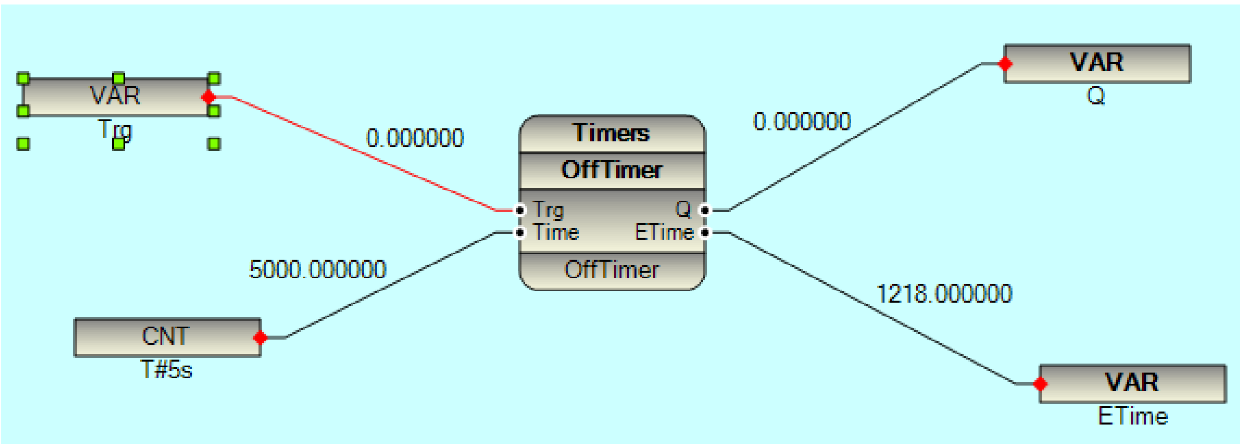


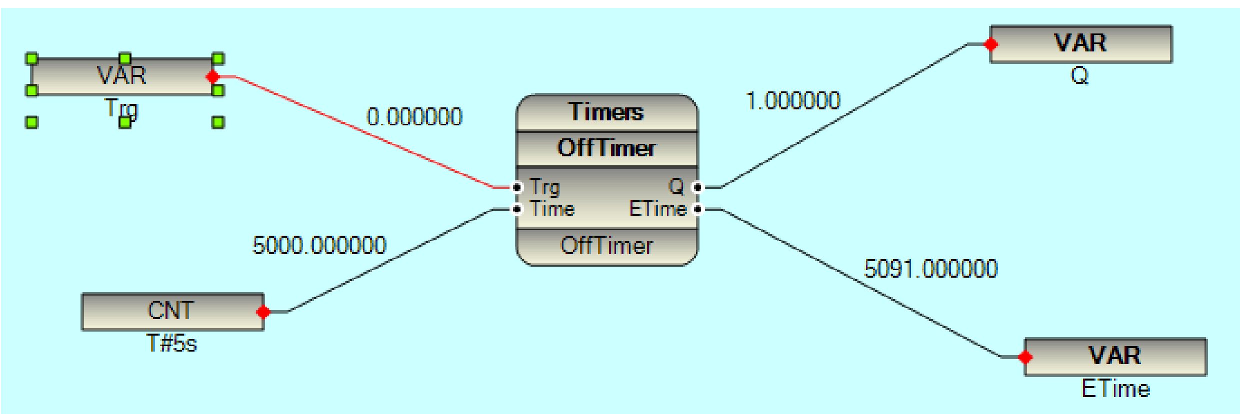


If Trg Input Changed from 1 to 0 , Time will reset .(Q and ETime Output change to 0)

OffTimer : When Trg Input Change from 0 to 1 , Time will armed (Q = 0 , ETime = 0) and wait for detecting Trg Falling from 1 to 0 . When Trg Changed from 1 to 1 , Timer will start and after Time Msec , Q will change to 1 . ETime shows Passed Time in Msec .





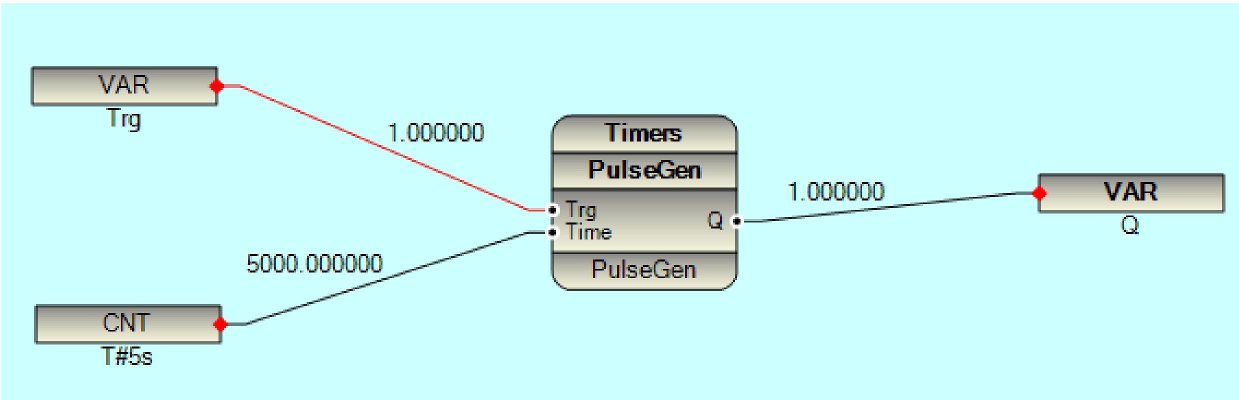


PulseGen : This FB Generate Permanent Pulse in Output Q . When Trg Changed from 0 to 1 , Output Pulse will start .

Q High Time = Time (Msec)

Q Low Time = Time (Msec)

When Trg Changed from 1 to 0 , pulse will stop .

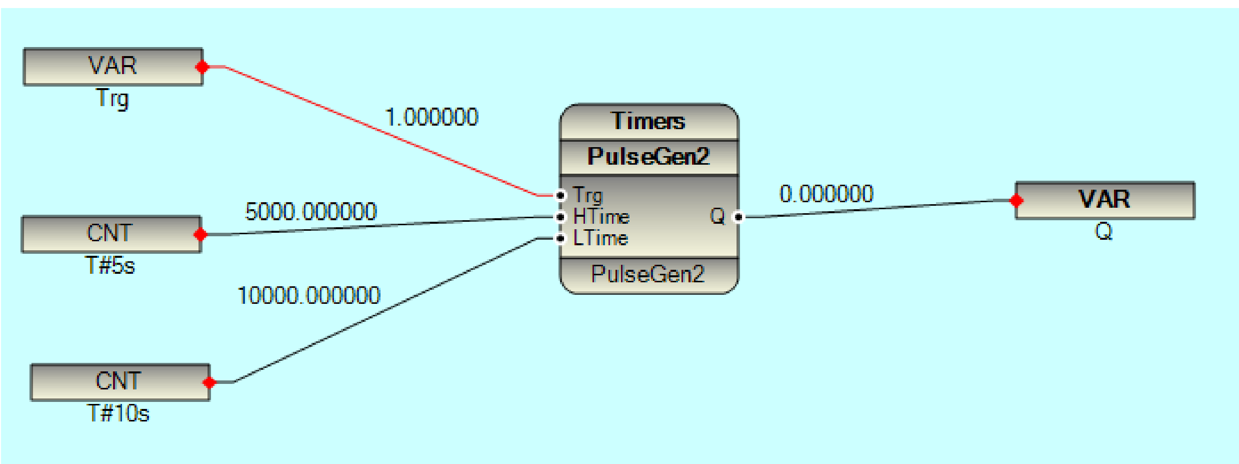


PulseGen2 : This FB Generate Permanent Pulse in Output Q . When Trg Changed from 0 to 1 , Output Pulse will start .

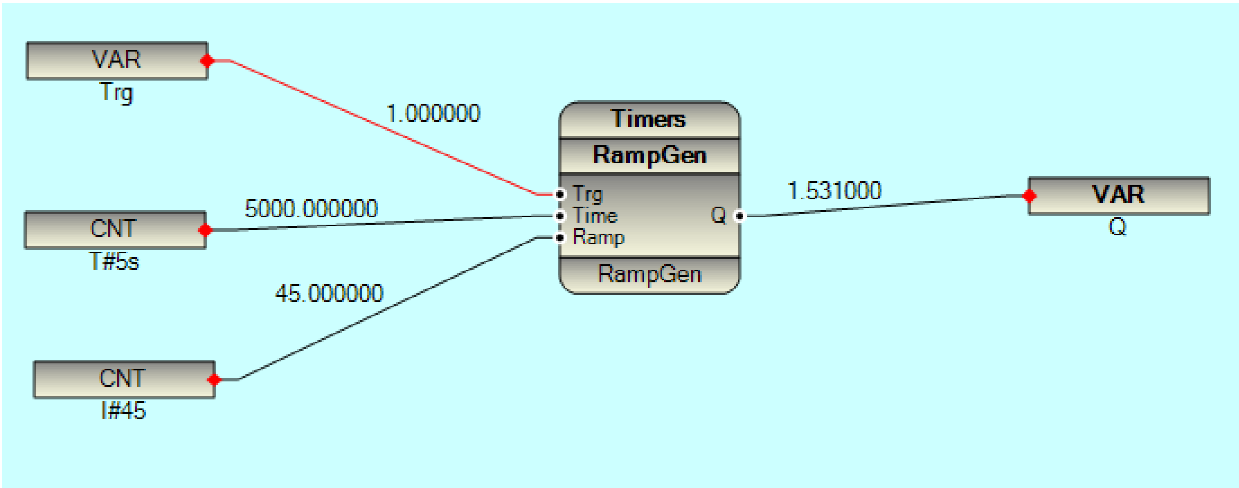
Q High Time = HTime (Msec)

Q Low Time = LTime (Msec)

When Trg Changed from 1 to 0 , pulse will stop .



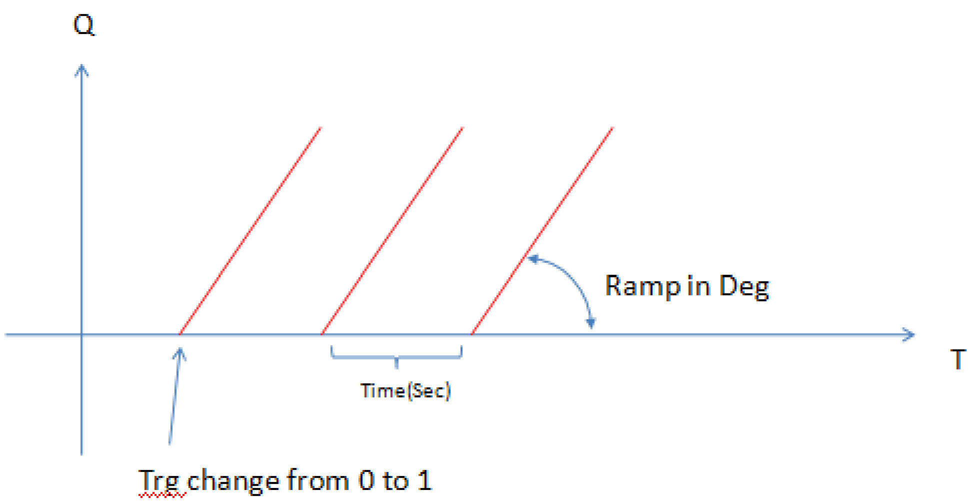
RampGen : This FB Generate Ramp Output .



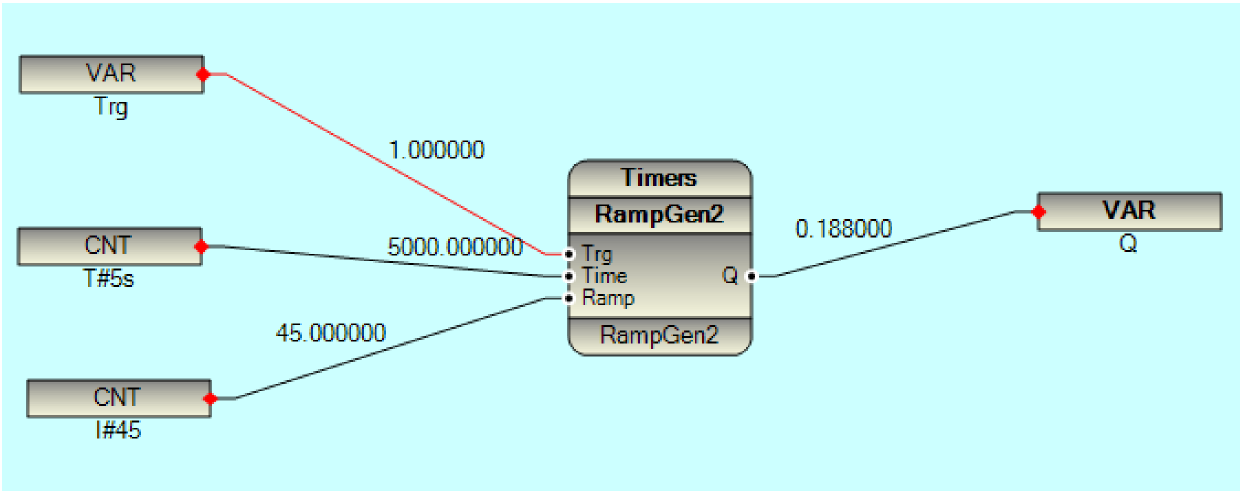
When Trg Change from 0 to 1, FB Will Start.

Time is in Sec, width of Ramp.

Ramp: Ramp angle in Deg



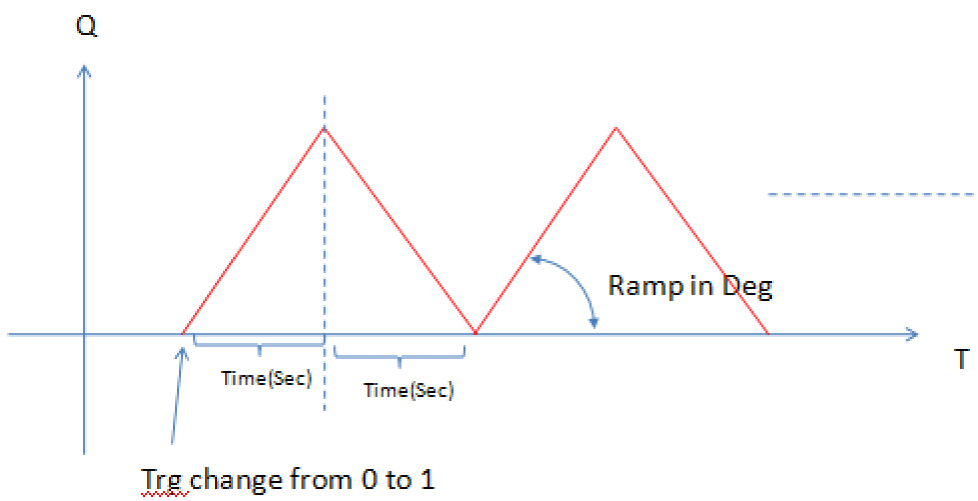
RampGen2 : This FB Generate Ramp Output .



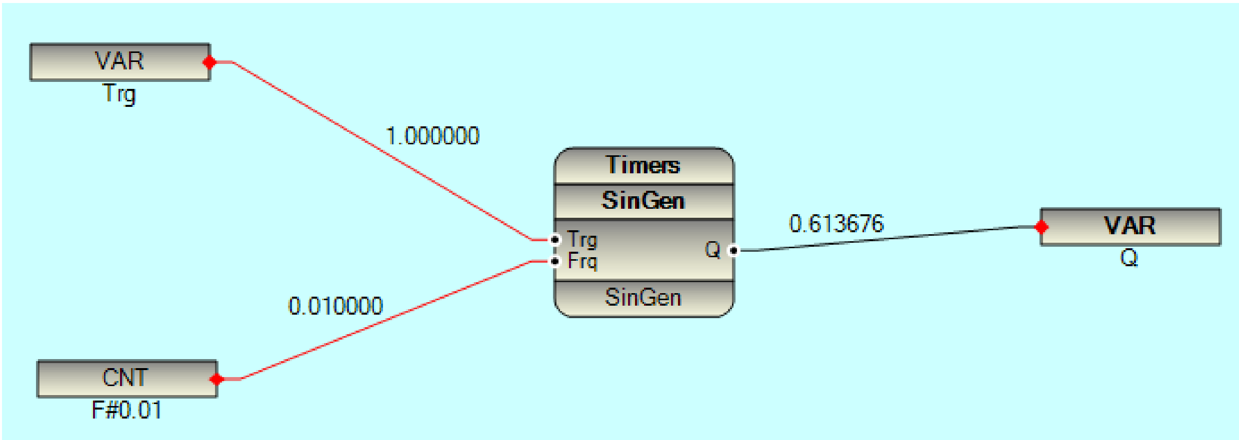
When Trg Change from 0 to 1, FB Will Start.

Time is in Sec, width of Ramp.

Ramp: Ramp angle in Deg



SinGen : This FB Generate Sine Output

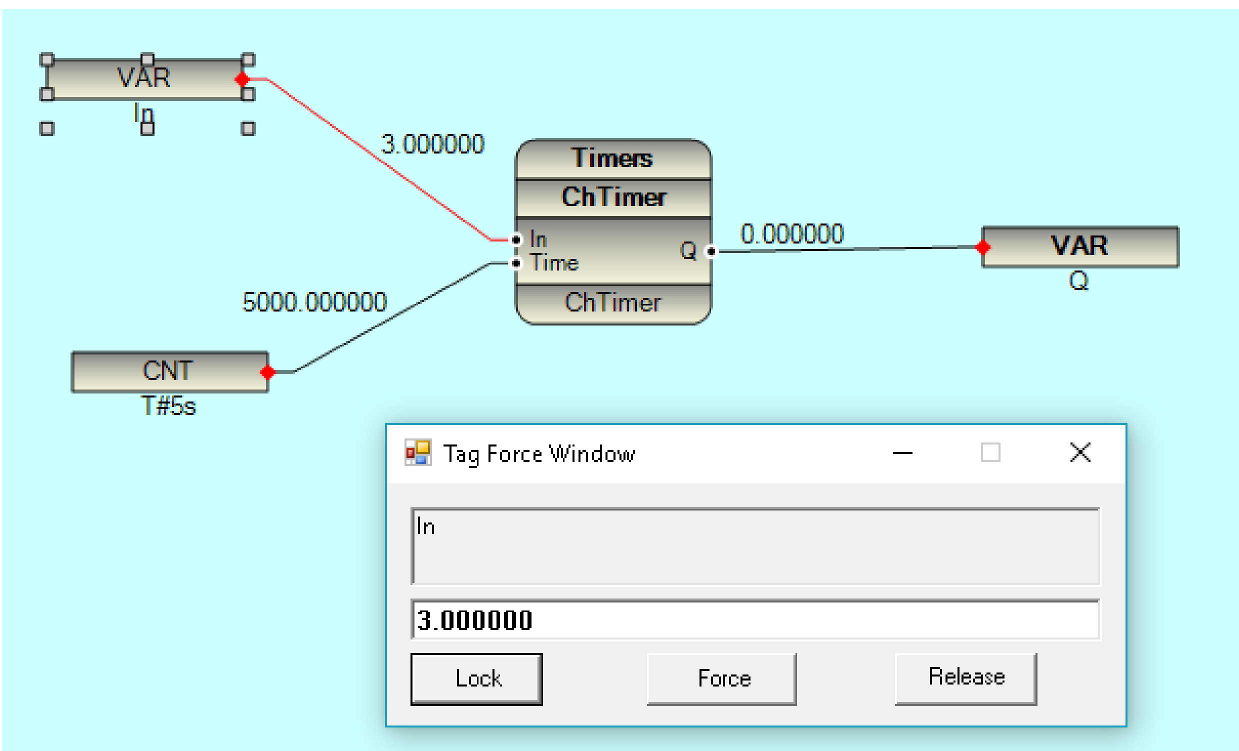


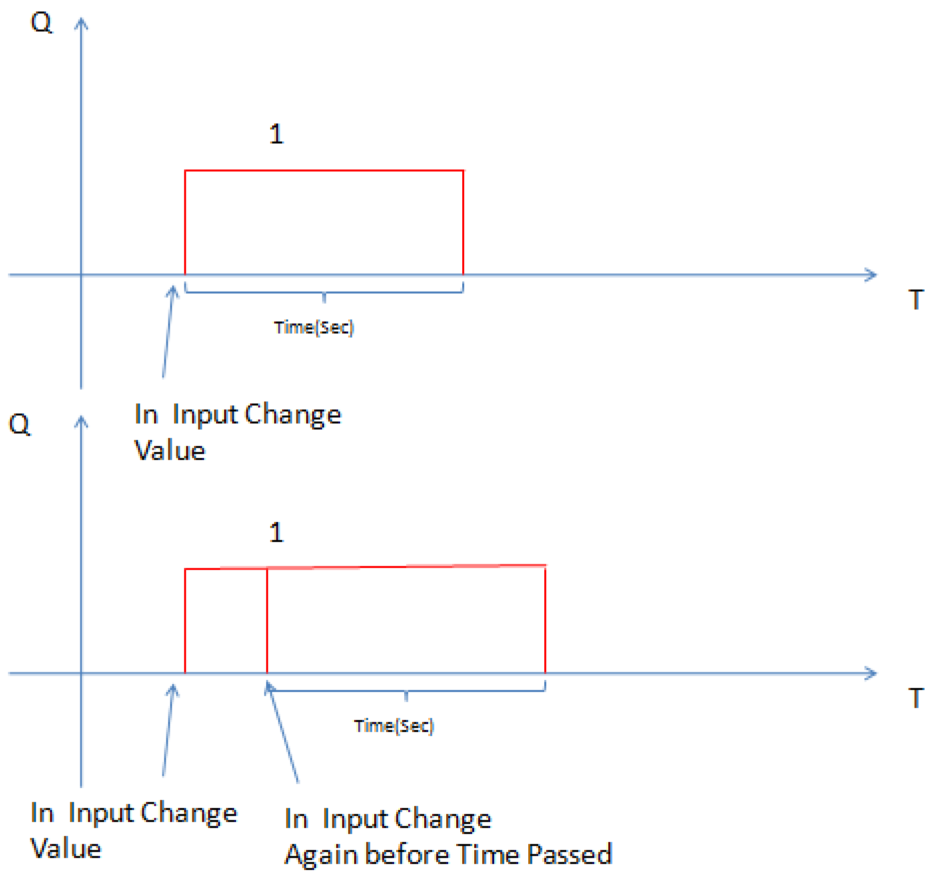
Trg : When change from 0 to 1 , FB start to make Sine output

Frq : Sine Frequency

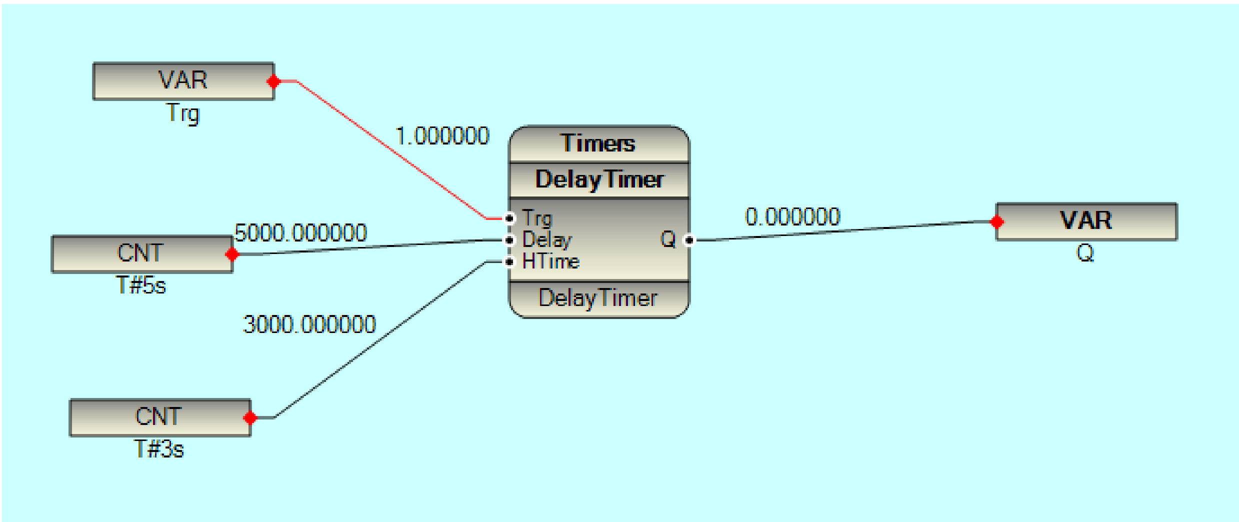
Q : Sine Signal

ChTimer : Change Timer . When In Input changing , Q Output will set to 1 for Time Value . in following sample when In signal is changing from 0 to 3 , Q is set for 5 sec and Q will fall after 5 sec .

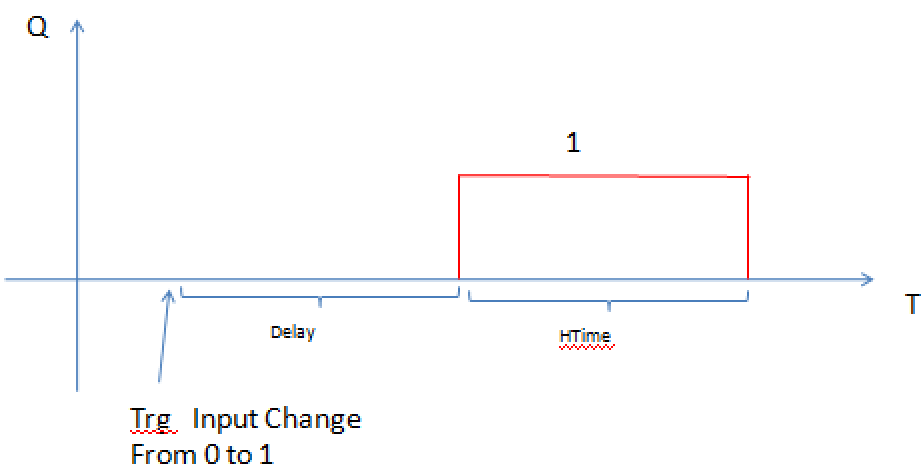



Q
1
T
Time(Sec)
In Input Change Value
Q
1
T
Time(Sec)
In Input Change Value
In Input Change Again before Time Passed

DelayTimer : Delay Timer



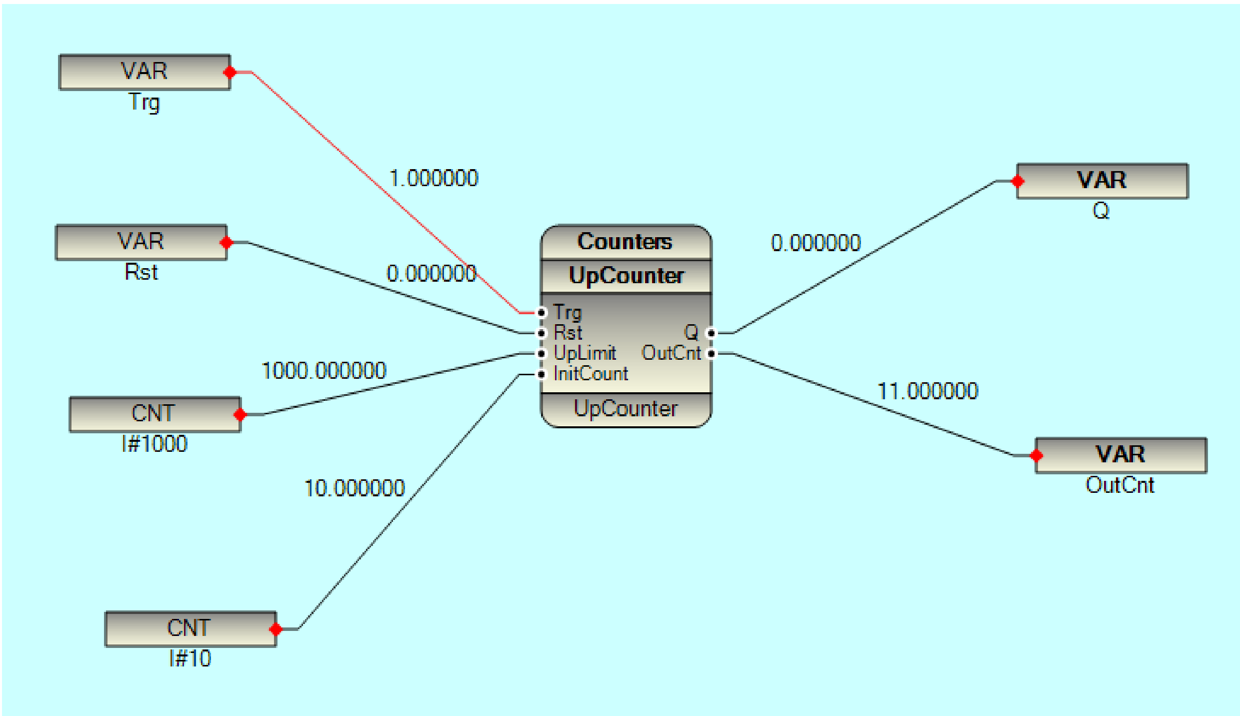
When Trg Input change from 0 to 1 , after Delay Time , Q will change to 1 for HTime .



1

Counter Group:

UpCounter : When Trg Input Change from 0 to 1 , OutCnt will increase by One . When OutCnt reach to UpLimit then Q will set to 1 and OutCnt will not change any more , until Rst Signal is changed from 0 to 1 .

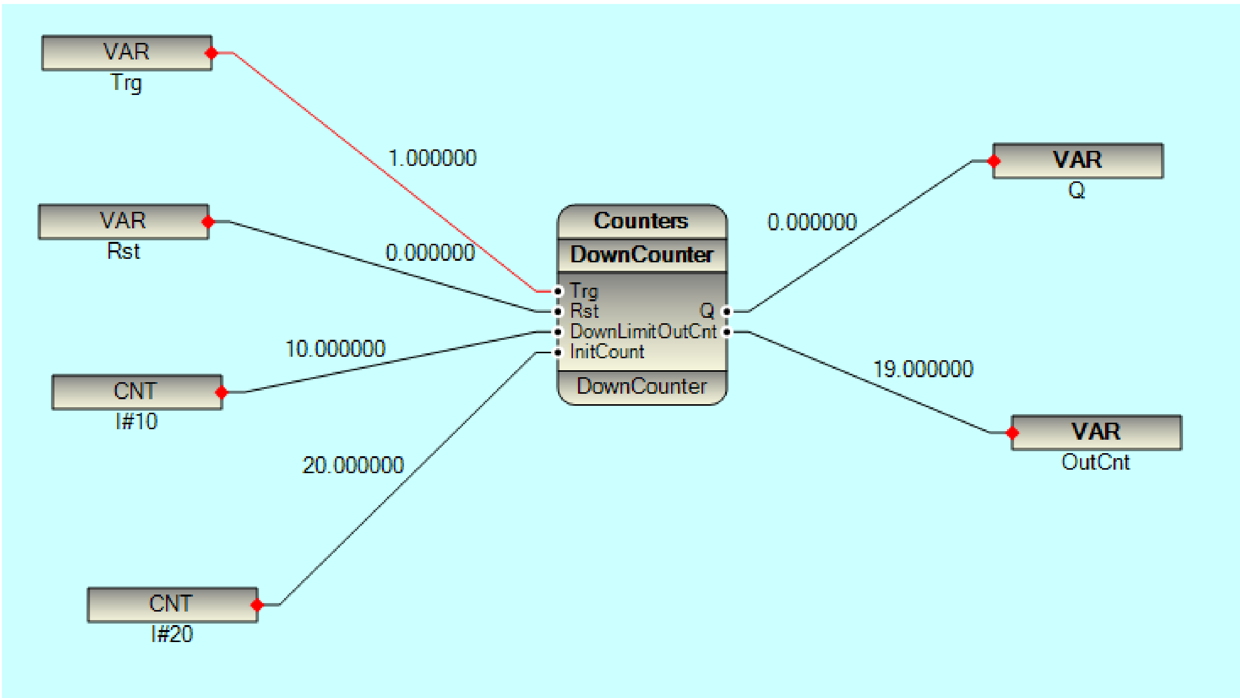


When Rst Is changed from 0 to 1 : OutCnt set to InitCount , Q set to 0

When Trg Changed from 0 to 1 : If OutCnt is not reached to UpLimit , OutCnt increase by one .

If OutCnt reach to UpLimit then Q will set to 1 .

DownCounter : When Function block is run for first time (There is no Static data for FB) , OutCnt will set to InitCount .



When Trg changed from 0 to 1 , OutCnt will decrease by one . When OutCnt reached to DownLimit , then Q will set to 1 and OutCnt will not changed until Rst Input changed from 0 to 1 .

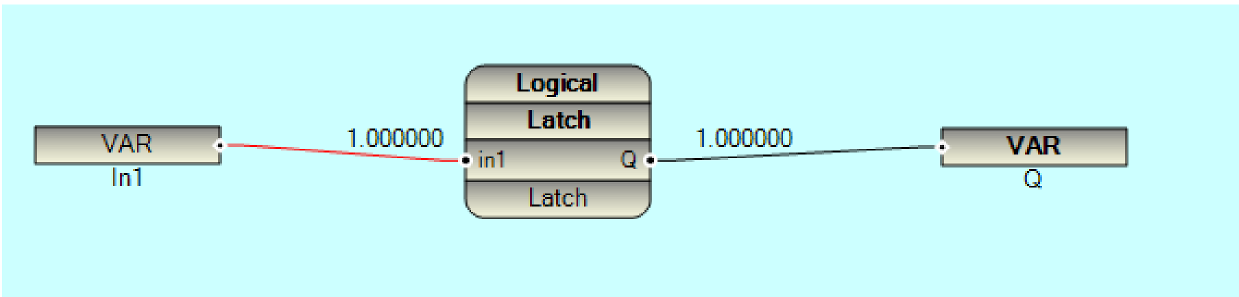
When Rst Input changed from 0 to 1 : OutCnt will set to InitCount , Q will set to 0

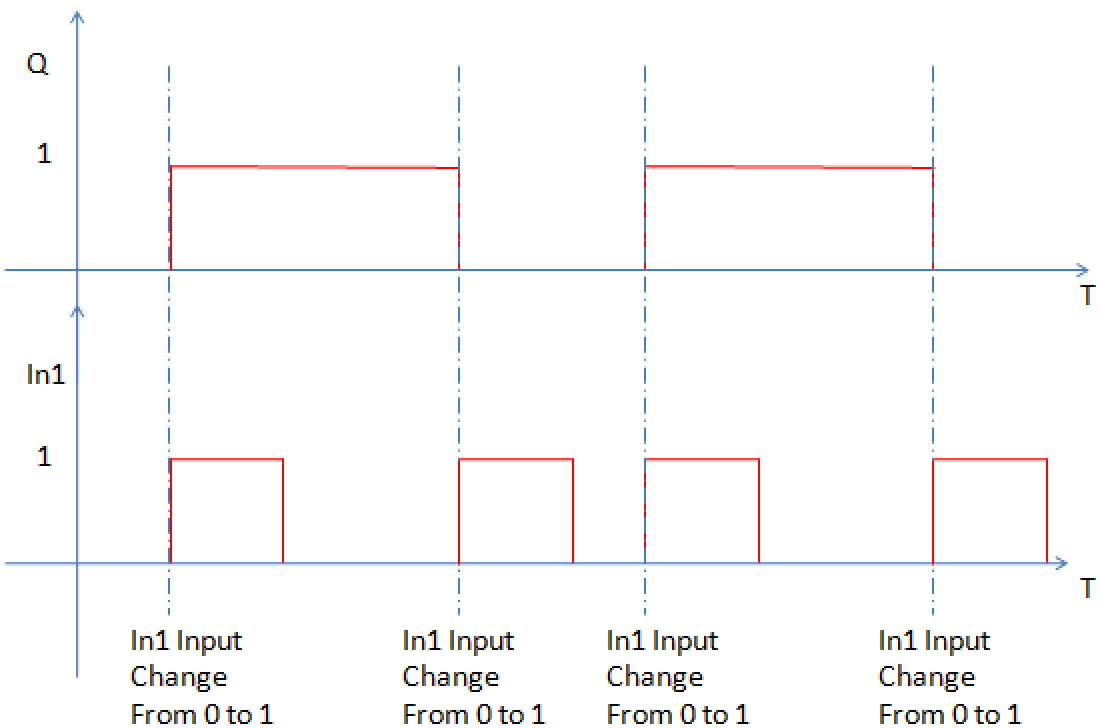
When Trg Changed from 0 to 1 , If OutCnt is bigger than DownLimit , Outcnt will decrease by one , Q is set to 0

When Trg Changed from 0 to 1 , If OutCnt is equal to DownLimit , Outcnt will set to DownLimit , Q will set to 1

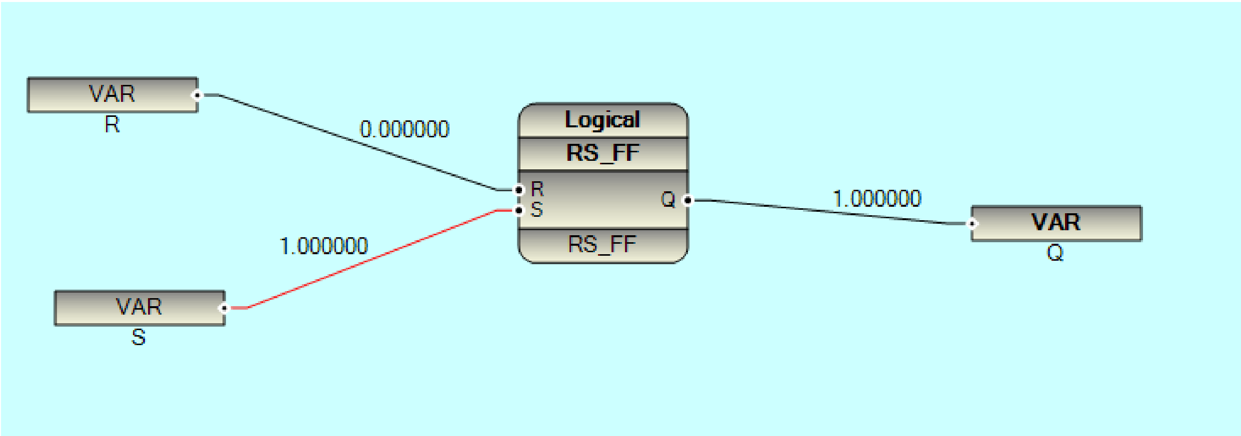
Logical Group:

Latch : Latch Function . When In1 changed from 0 to 1 , Q will set to 1 . Q is set to 1 until In1 is changed again from 0 to 1 .





RS_FF : Reset Set Flip Flop .

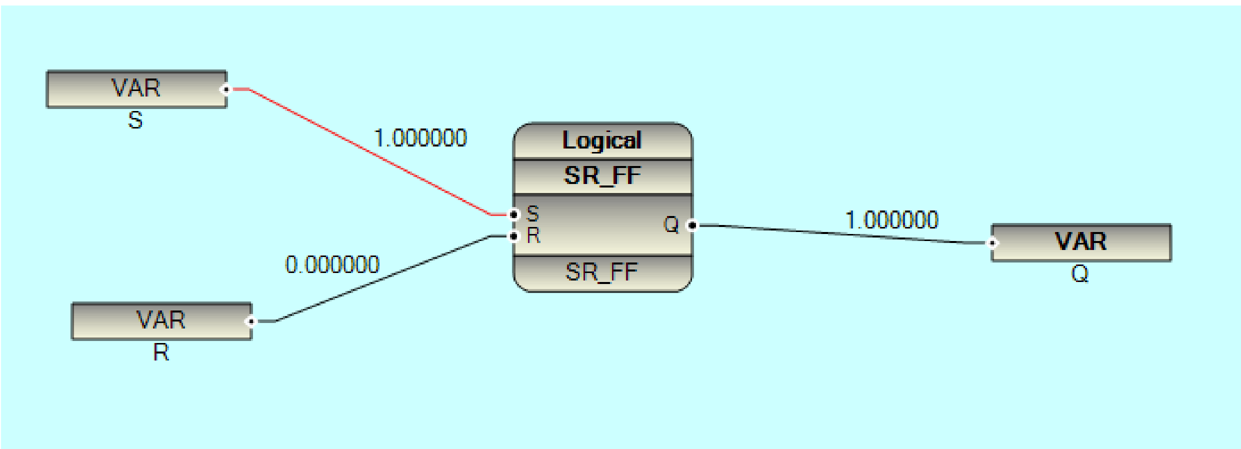


When R Input changed from 0 to 1 : Q will set to 0

When S Input Changed from 0 to 1 : Q will set to 1

If R and S changed from 0 to 1 at same time, Q will set to 0.

SR_FF : Set Reset Flip Flop .

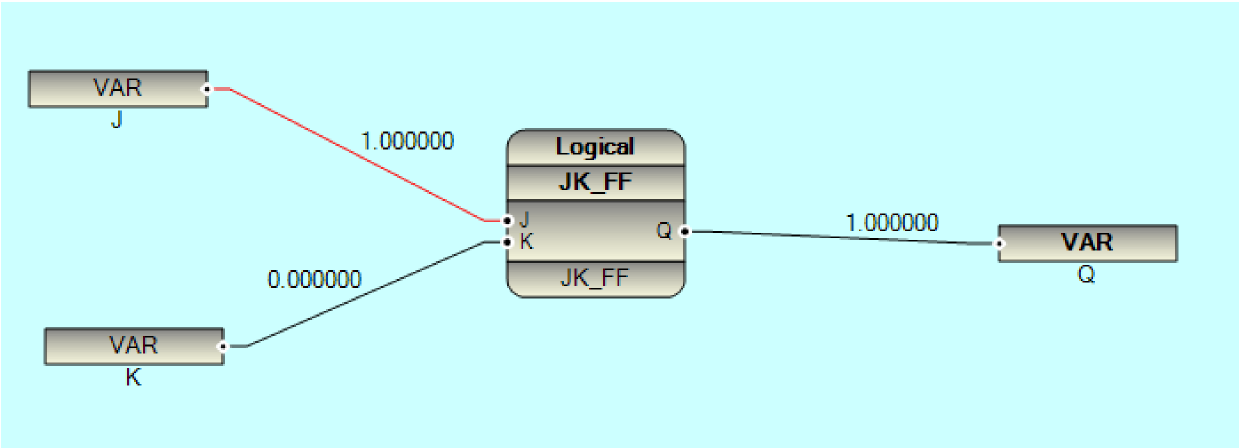


When S Input Changed from 0 to 1 : Q will set to 1

When R Input changed from 0 to 1 : Q will set to 0

If R and S changed from 0 to 1 at same time, Q will set to 1.

JK_FF : JK Flip Flop .



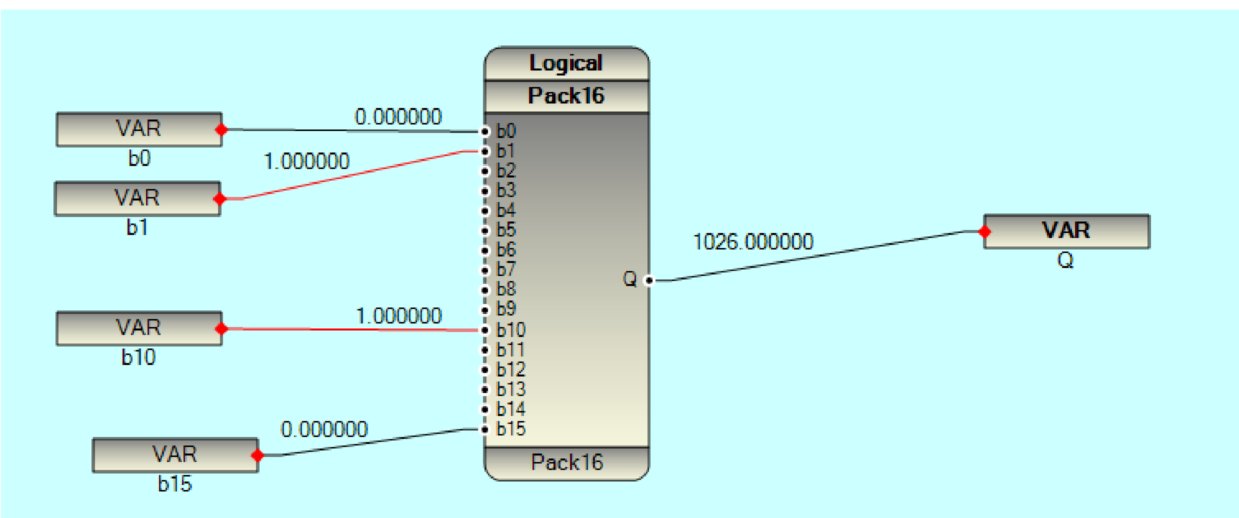
If J is changed from 0 to 1 : Q will set to 1

If K is changed from 0 to 1 : Q will set to 0

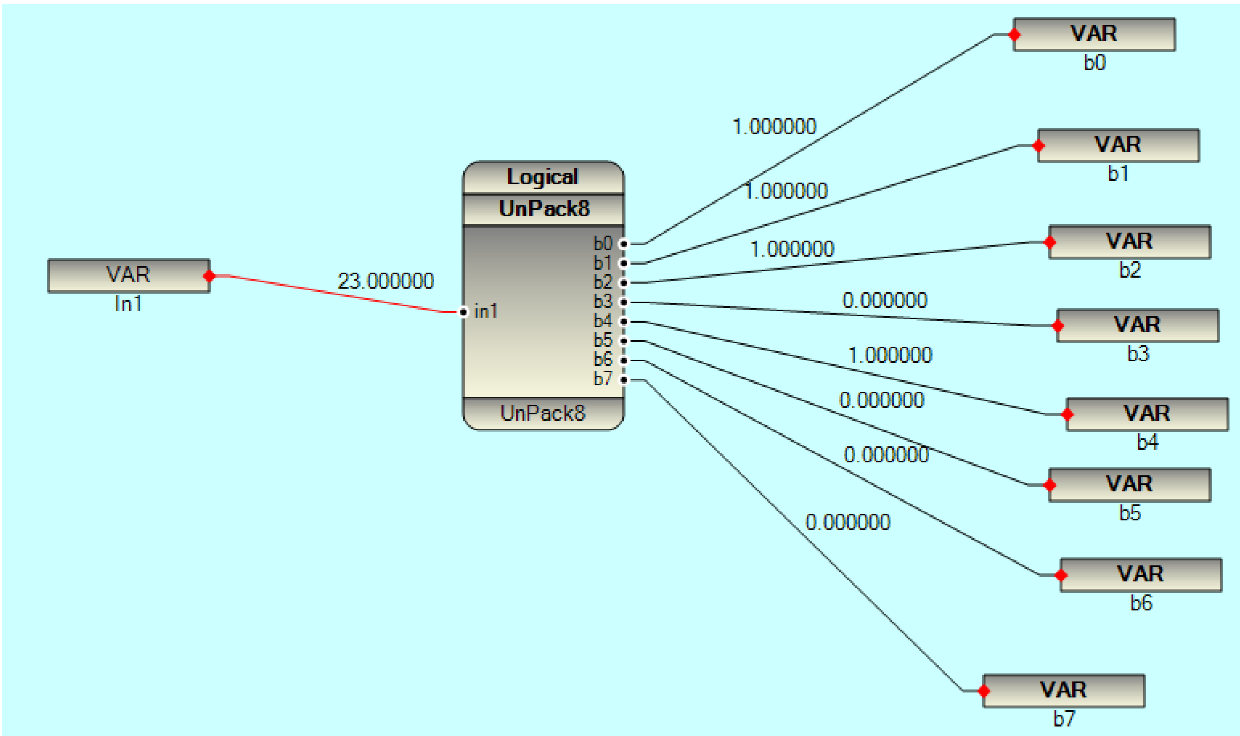
If J & K changed for m0 to 1 In the same time:

- If Q is 1 , Q will set to 0 .
- If Q is 0 , Q will set to 1.

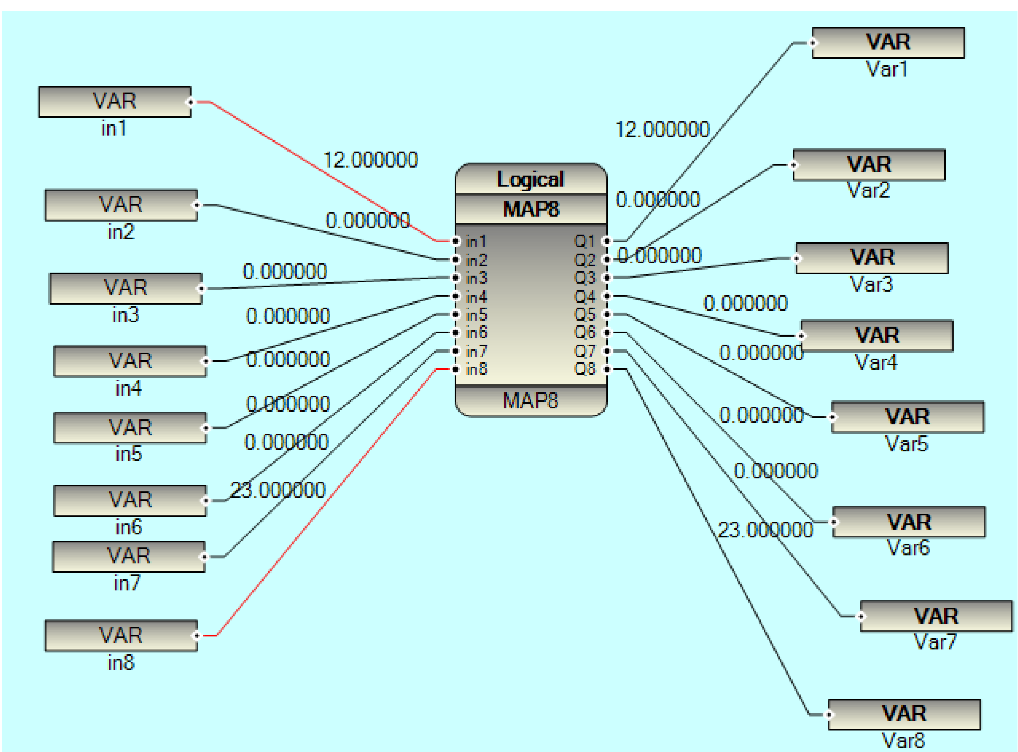
Pack8 /16 : Pack8/16 will combine 8/16 digital signal (0 or 1) to one 8/16 Bit integer value .



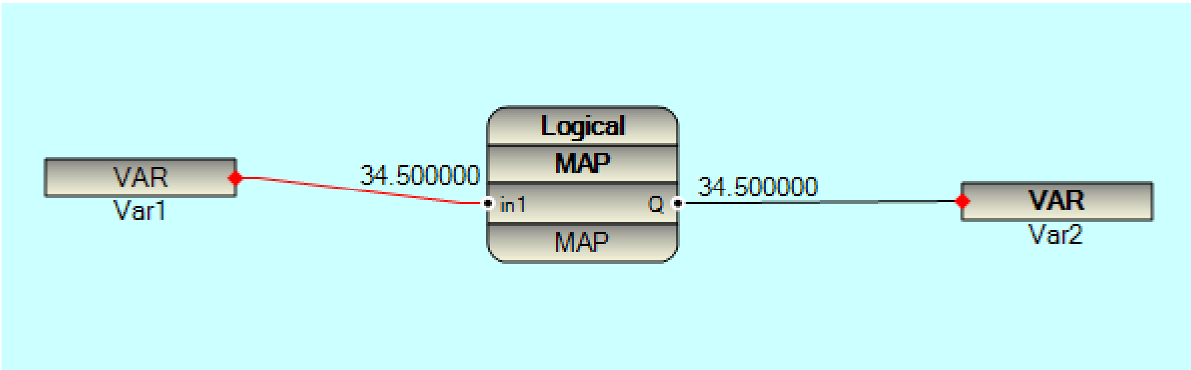
UnPack8/16 : Convert one 8/16 bit integer to 8/16 digital signal (0 or 1)



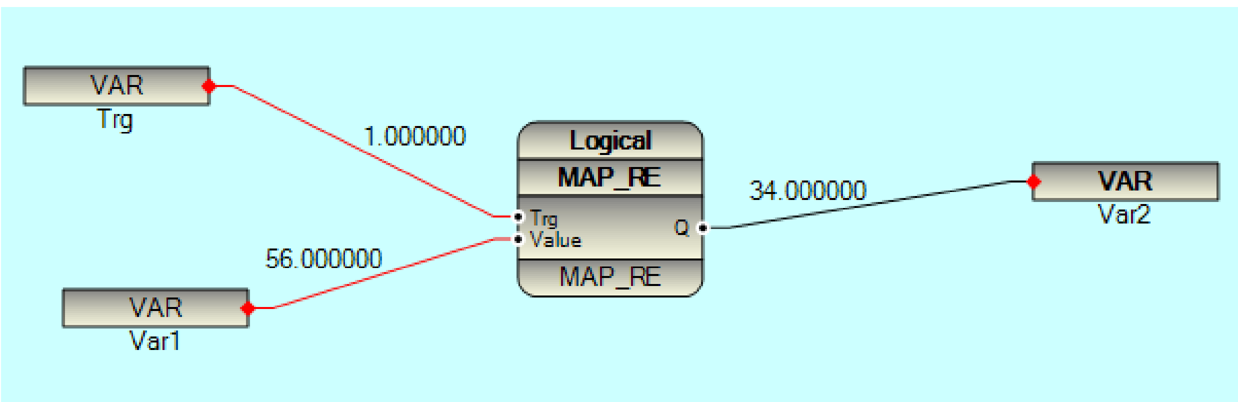
Map8 : Map 8 Input signals independently to 8 Output Signals



Map : Map Input signal to Output Signal

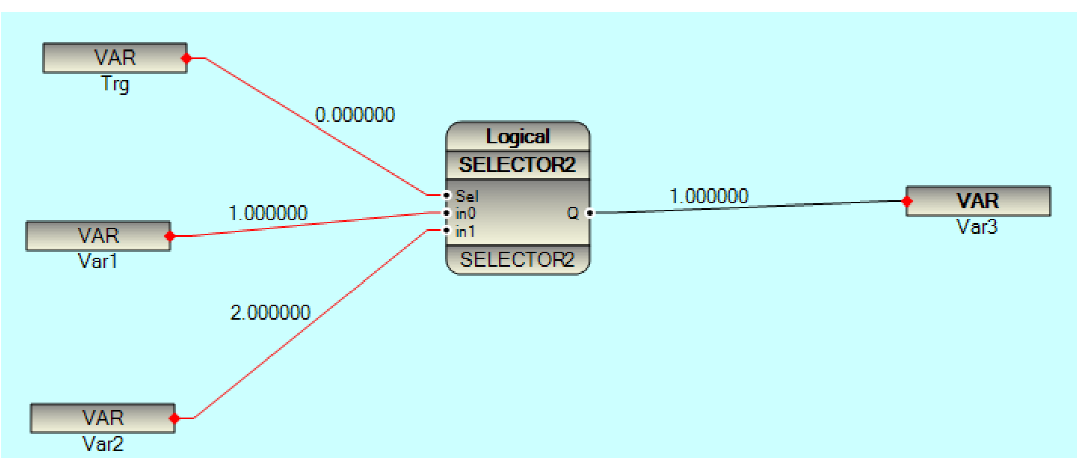


Map_RE: Map value to Q when Trg changed from 0 to 1 .



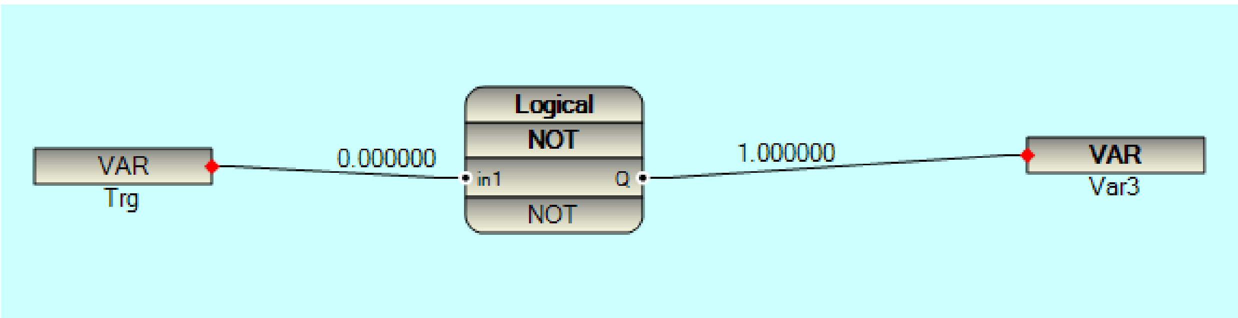
When Input Value is changed, it will not map to Q until Trg is changed from 0 to 1 .

Selector2: When Sel Signal is 0 , in0 is mapped to Q , When Sel is 1 , in1 is mapped to Q.

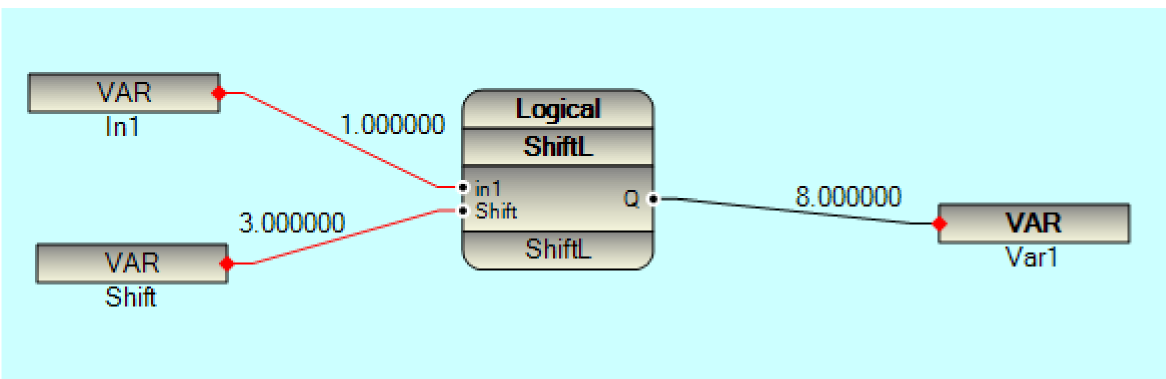


NOT: Reverse Function

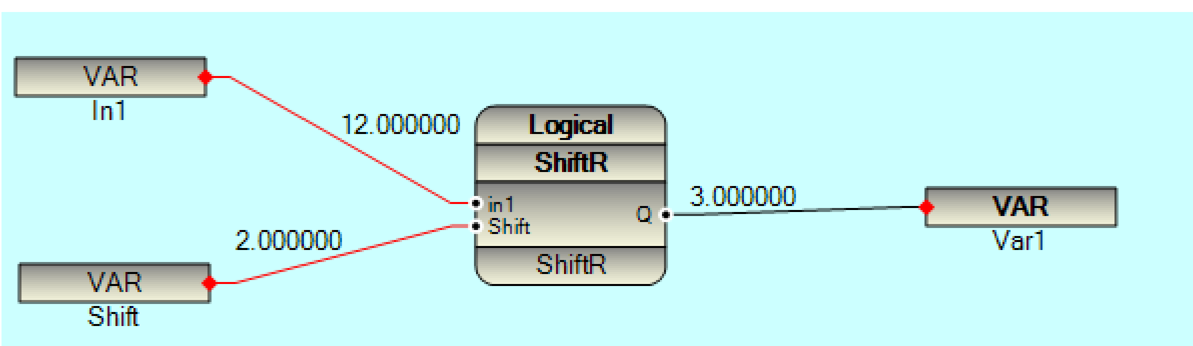
- when In1 is 0 , Q is 1
- When In1 is not 0 , Q is 0



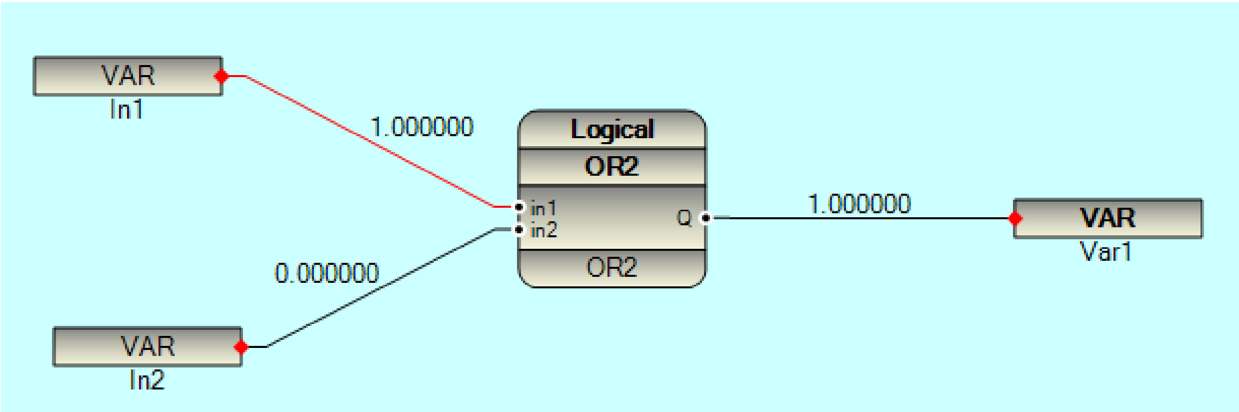
ShiftL: Shift Left . In1 Signals is shift to left side by Shift Number .



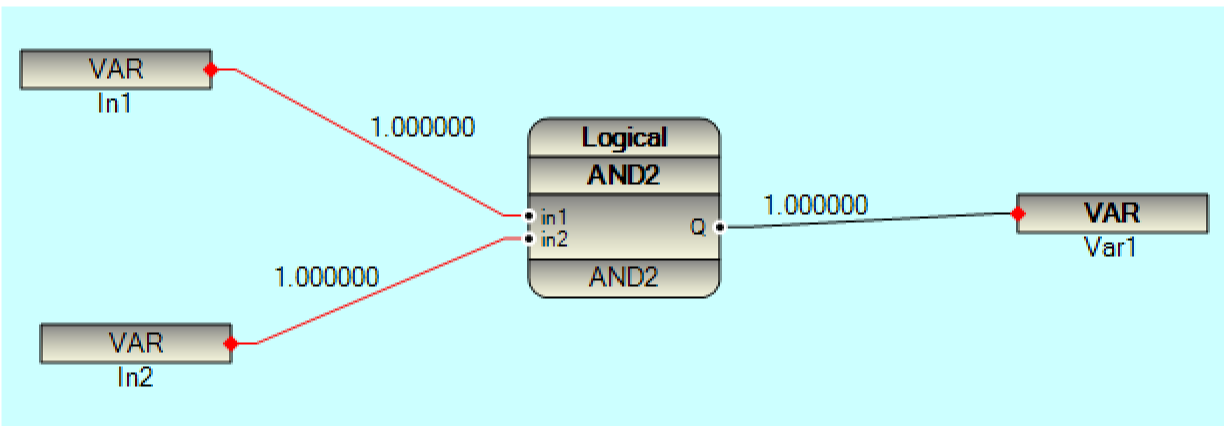
ShiftR: Shift Right . In1 Signals is shift to right side by Shift Number .



OR2/OR3/OR4/OR5/OR6/OR7/OR8: Make OR all input signals and map to Output.



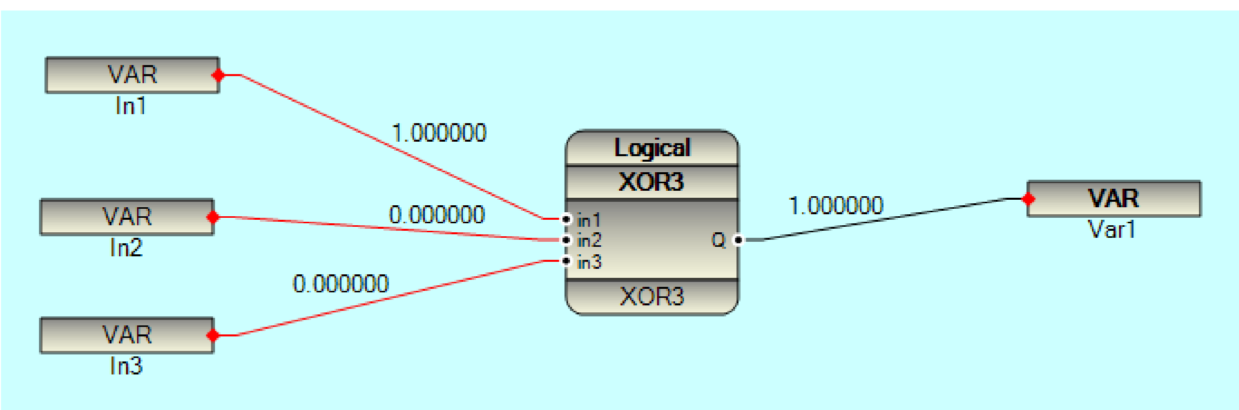
AND2/AND3/AND4/AND5/AND6/AND7/AND8: Make AND all input signals and map to Output.



XOR2/XOR3/XOR4/XOR5/XOR6/XOR7/XOR8: Make XOR all input signals and map to Output.

When all Input Signals or just one input is 1 , Q will set to 1

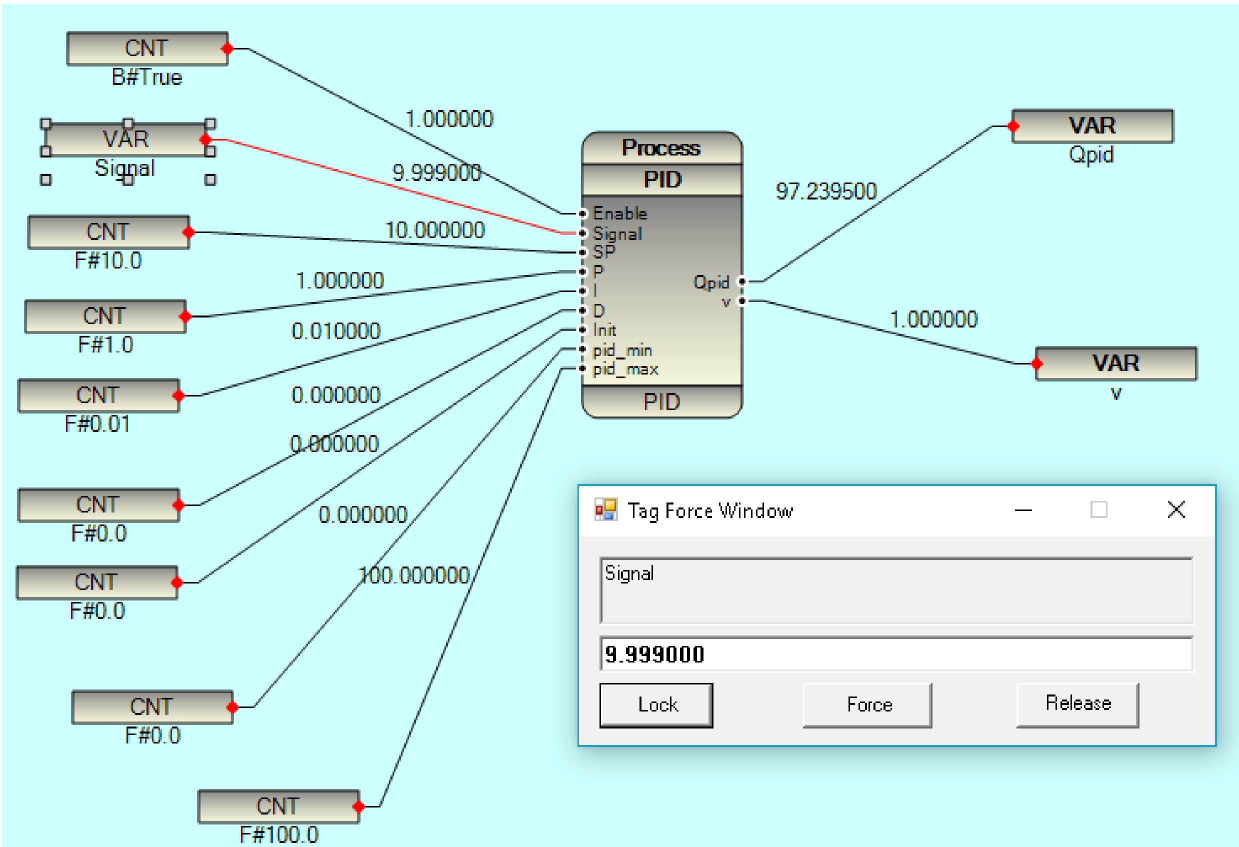
Otherwise Q is set to 0



Process Group:

PID: This Function Block is Standard PID Function.

```
if(Enable==1)
{
     Error = SP - Signal;
     if (fabs(Error)<0.01)
     {
         Error = 0;
     }
    double delta = ErrorOld - Error;
    double DelaTime = (pbsgetTime() - TmpTimeOld)/1000; // sec
    double derivative = delta / DelaTime;
    double Integral = ((ErrorOld + Error)/2) * DelaTime +IntegralOld;
    IntegralOld = Integral;

    pidQ = (Error * P) + (Integral  * I) + (derivative * D) +Init;
    if((pidQ>PidMin) &&(pidQ<PidMax))
    {
        pidV = 1;
    }
    else
    {
        pidV = 0;
        if((pidQ<PidMin))
        {
            pidQ = PidMin;
        }
        else
        {
            if((pidQ>PidMax))
            {

                  pidQ = PidMax;
              }
          }
      }

      ErrorOld = Error;
  }// Enable
  else
  {
      pidQ = 0;
      pidV = 0;
  }
```



Enable: When Enable is 1 , Function Block is Enable , otherwise Outputs are 0 .

Signal : Input signal which should be controlled by FB .

SP : Set Point

P : Proportional parameter

I: Integral Parameter

D : Derivative Parameter

Init : Init (Bias) Value of Output

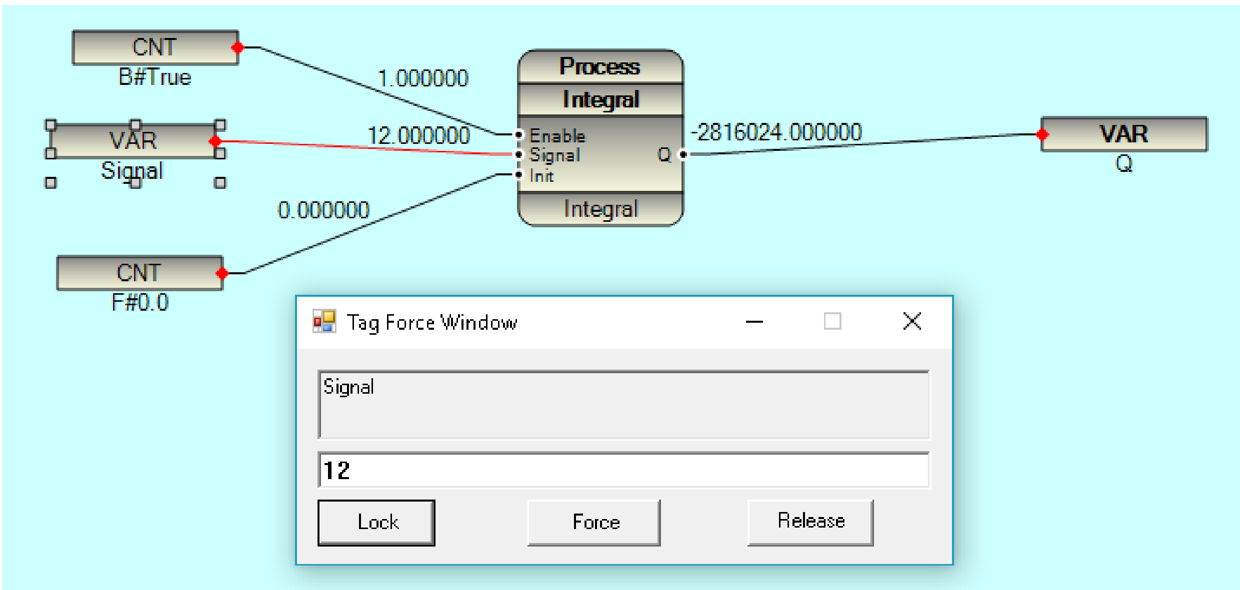
Pid_Min : Minimum Value of Output signal

Pid_Max : Maximum Value of Output Signal

Qpid : PID Output signal

V : Validity Signal . When QPid Signal is between pid_min and pid_Max , V is set to 1 (Output is Valid) otherwise it is set to 0

Integral: This Function Block is Standard Integral Function.




```
if(Enable==1)
{

    double DelaTime = (pbsgetTime() - TmpTimeOld)/1000; // sec
    pidQ = ((SignalOld + Signal)/2) * DelaTime +IntegralOld;
    IntegralOld = pidQ;
    pidQ = pidQ+Init;
}// Enable
else
{
    pidQ = 0;
}
```

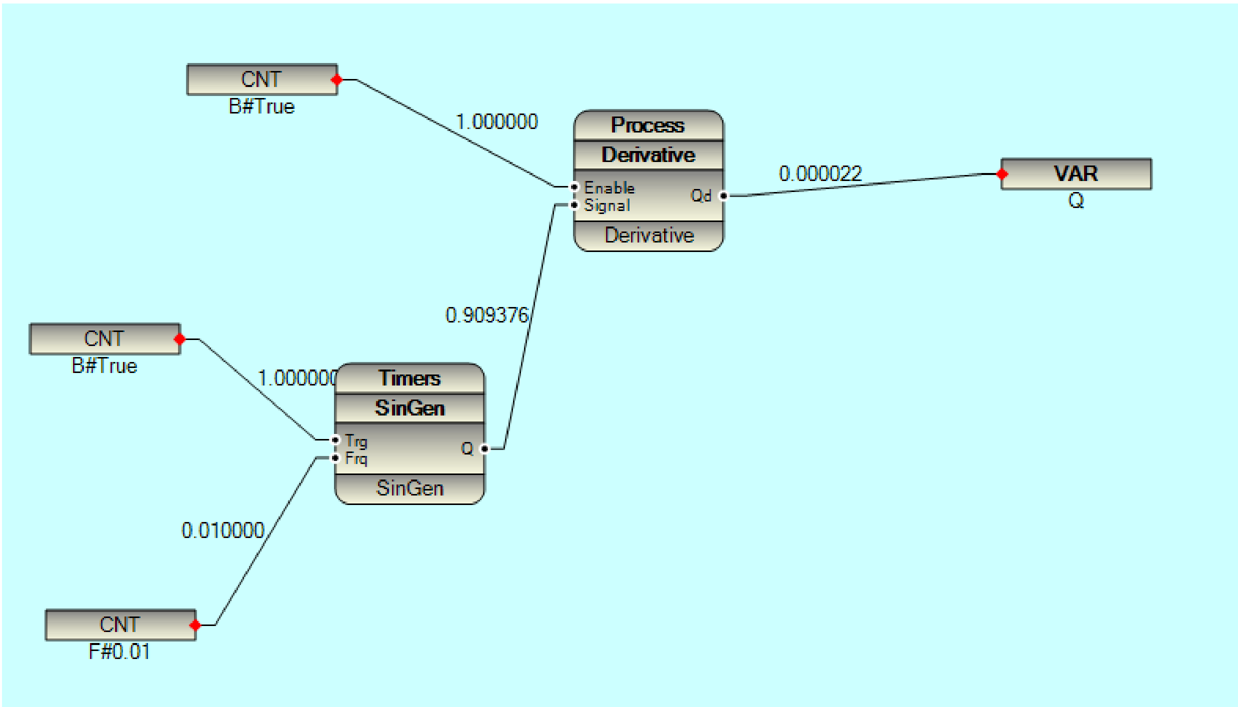
Enable : When 1 , FB is enabled , Otherwise FB Output is 0

Signal : Input Signal for getting integral

Init : Init (Bias) Value for integration

Q : Integrated Output signal

Derivative : This Function Block is Standard Derivative Function.



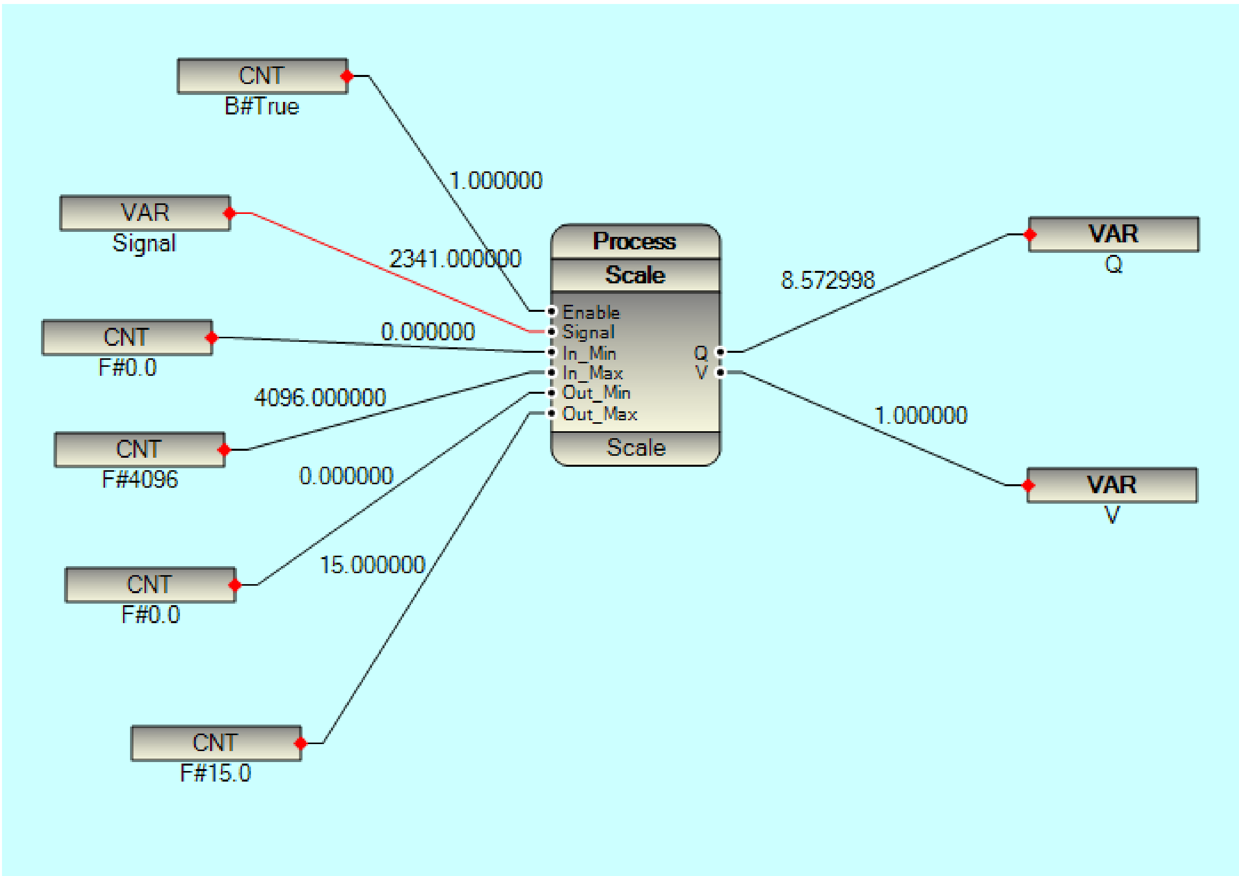

```
if(Enable==1)
{


    double DelaTime = (pbsgetTime() - TmpTimeOld)/1000; // sec
    double Delta = SignalOld - Signal ;
    pidQ = Delta / DelaTime;
}// Enable
else
{
    pidQ = 0;
}
```

Enable : When 1 , FB is enabled , Otherwise FB Output is 0

Signal : Input Signal for getting Derivative

Q : Output signal

Scale : This Function Block is Scaling Input Signal .



Enable : When 1 , FB is enabled , Otherwise FB Output is 0

Signal : Raw Input Signal

In_Min : Minimum Raw Value

In_Max : Maximum Raw Value

Out_Min : Minimum Value of scaled value

Out_Max : Maximum Value of Scaled Value

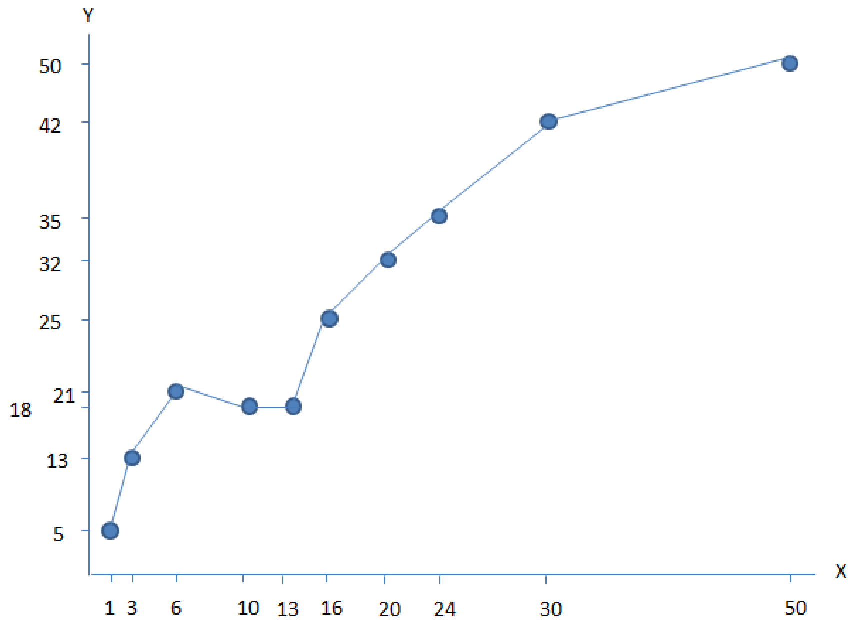
Q : Scaled Output signal

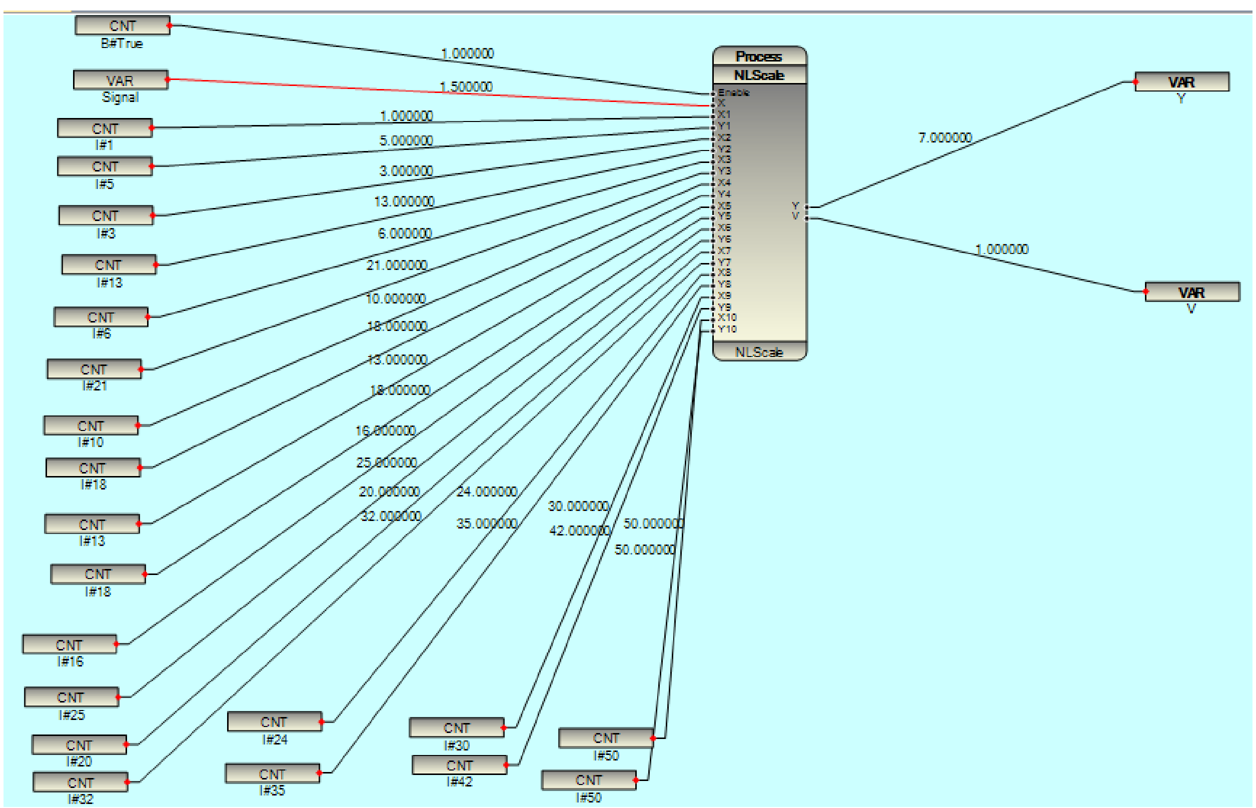
V : Validity . When Output Signal is between Out_Min and Out_Max , V is set to 1 , otherwise V is Set to 0

```
        TmpOut =Out_Min+((Out_Max -Out_Min )/(In_Max -In_Min ))*(TmpSignal-In_Min);

        if((TmpOut>=Out_Min) &&(TmpOut<=Out_Max))
        {
            TmpValid = 1;
        }
        else
        {
            TmpValid = 0;
            if(TmpOut>Out_Max)
            {
                TmpOut = Out_Max;

            }
            if(TmpOut<Out_Min)
            {
                TmpOut = Out_Min;
            }

        }
    }
    else
    {
        TmpOut = 0;
        TmpValid = 0;

    }
```

NScale : This Function Block is Nonlinear Scaling FB . you can model your scaling graph by 10 points

As an example suppose we want to scale a signal based on following diagram:





Enable : When 1 , FB is enabled , Otherwise FB Output is 0

X : Input Signal

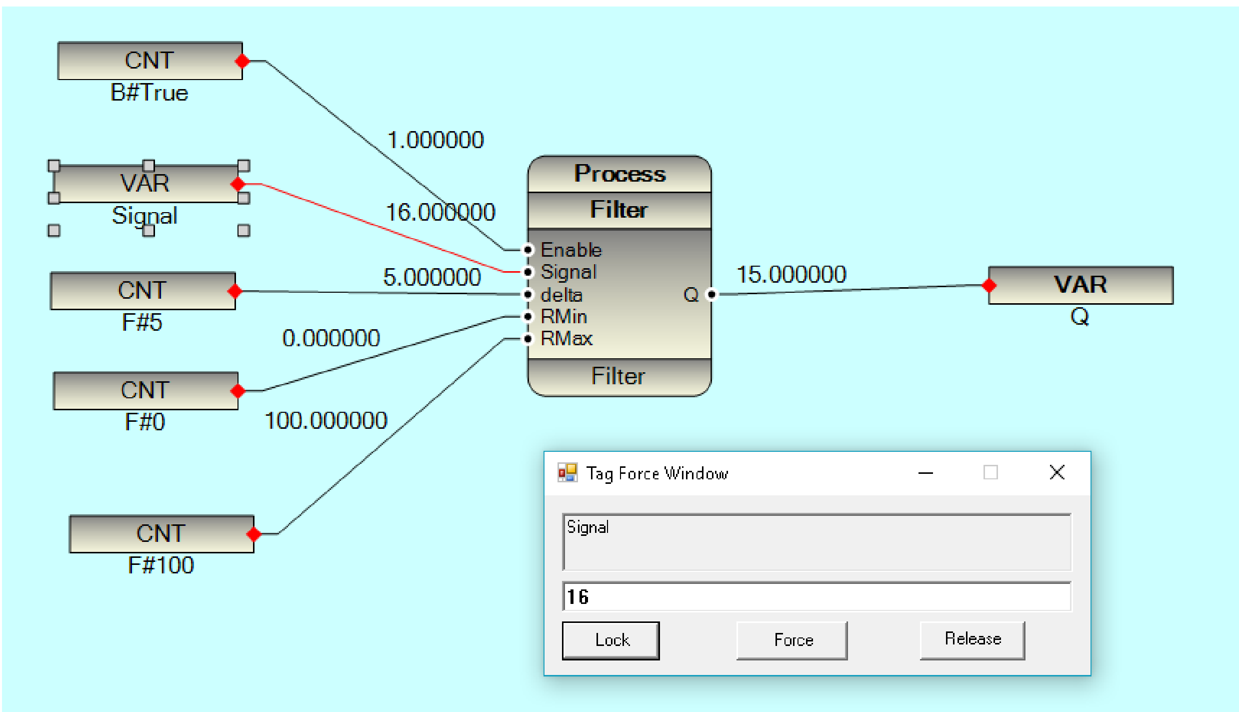
Xn,Yn : n = 1 , to 10 .

Y : Scaled Output Signal

V : Validity Signal . If X is less than X1 or bigger than X10 , V will set to 0 .

If X is between X1 and X10 , V will set to 1 .

Filter : This Function Block is Standard Digital Filter .



Enable : When Set to 1 , FB is operational

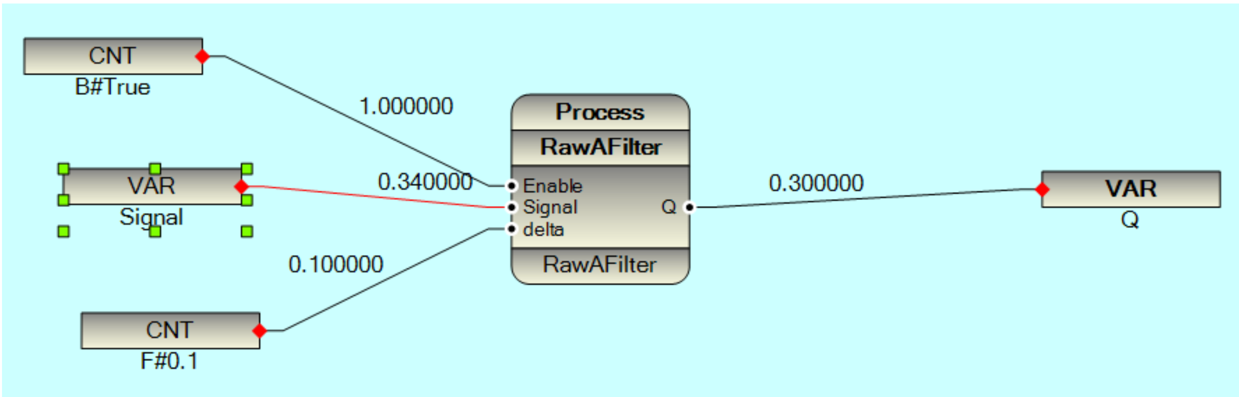
Signal : Input Signal

Delta : When Input Signal Changes is more than Delta (in percentage) then Current value of Signal will pass to Q Output .

RMin , RMax : Minimum and Maximum Range of Input Signal

In above example when Input signal changes is more than 5% then Input Signal will map to Output Signal , Otherwise old value will pass to output .

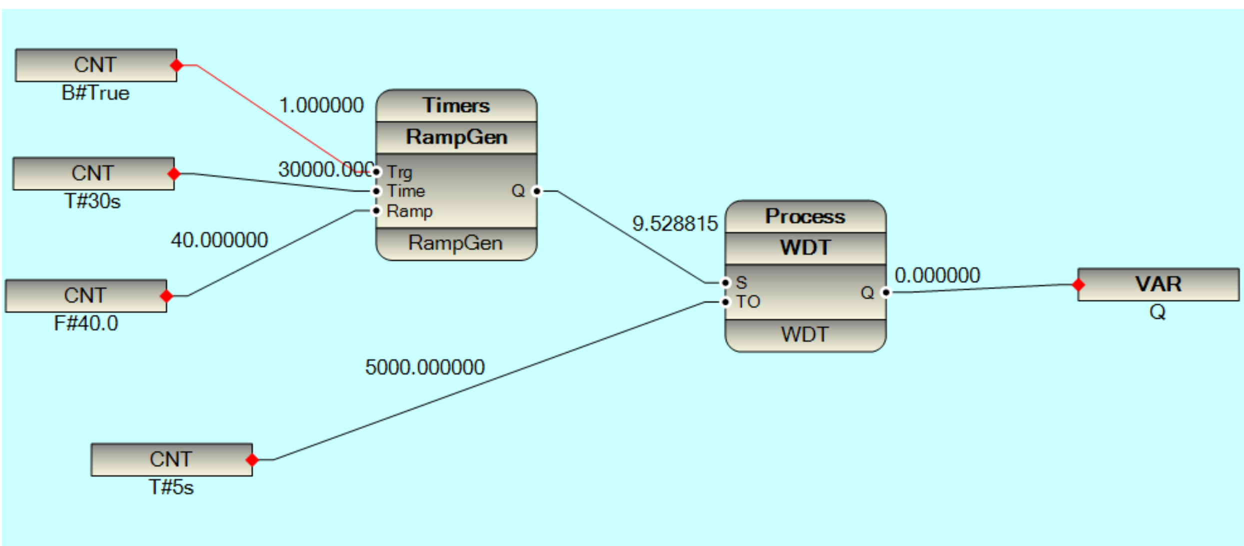
RawAFilter : This Function Block is Standard Digital Filter but it doesn't need Input Signal Min and Max range .



If Signal Changes is more than delta , it will map to Output , otherwise old value will map .

In abut example if Input Signal is changing for bigger than 0.1 , Current value of S Input Signal will map to Output . Otherwise old signal will pass .

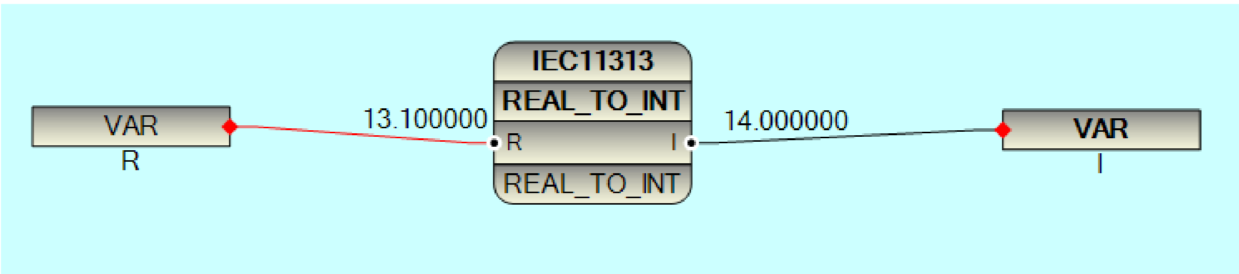
WDT : This Function is Watch Dog Function . If S input has any changes in less than TO , then Q Output is set to 0 . If S Input is not changed for more than TO time then Q Output will set to 1 .



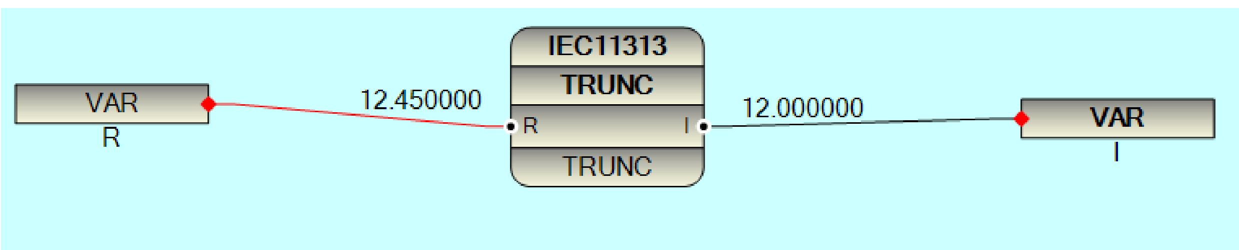
IEC1131-3 Group:

All Function blocks in this group are based on IEC1131-3 Standard. You will find some of this Function Blocks in Other group with different names. Function Block Name, Input Output Pins and Function definition is completely based on IEC1131-3 Standard.

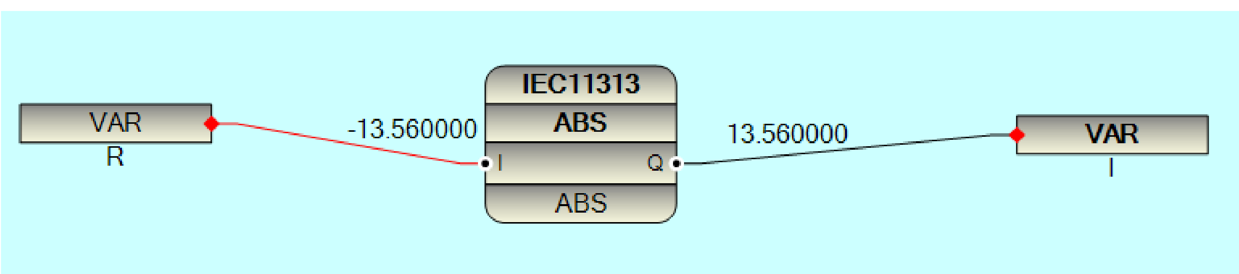
REAL_TO_INT : This Function round input signal upwards to nearest integer value .



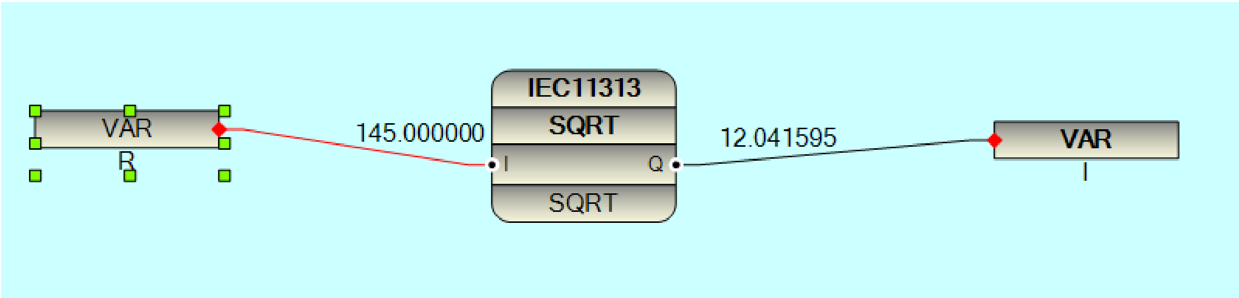
TRUNC : This Function round input signal downwards to nearest integer value .



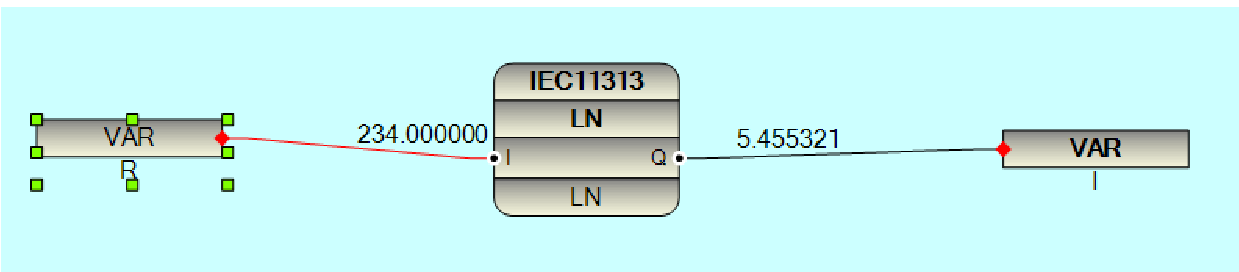
ABS : This Function map Absolute value of Input to Output .



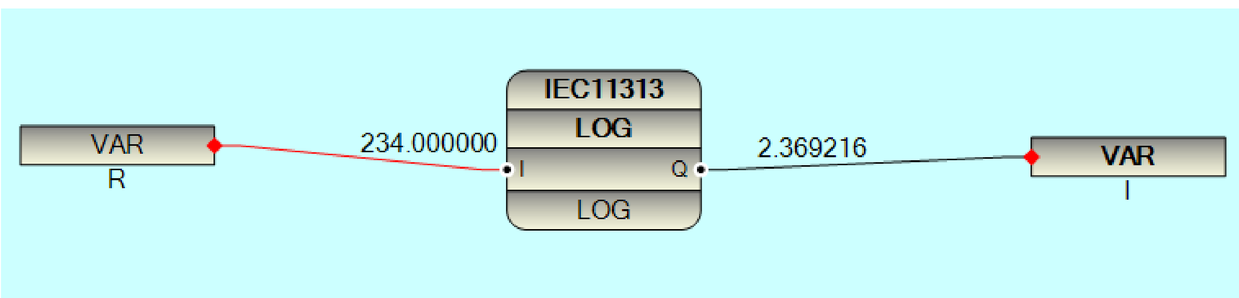
SQRT: This Function map square root of Input value to Output.



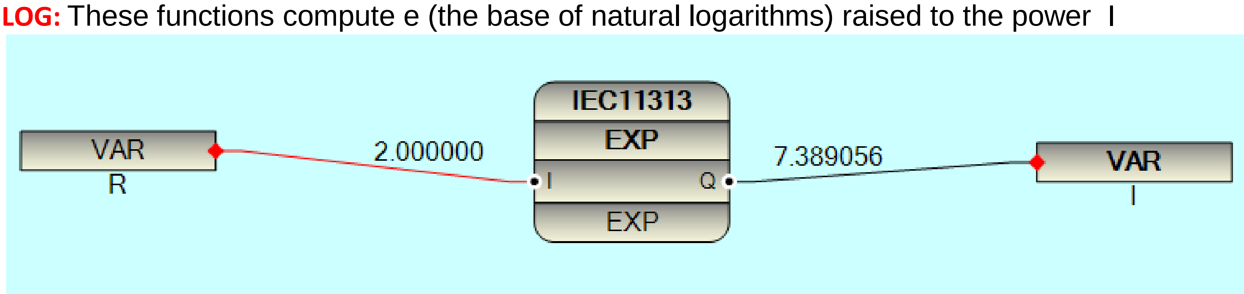
LN: This Function map Natural Logarithm of Input to Output



LOG: This Function map Logarithm (in Base 10) of Input to Output

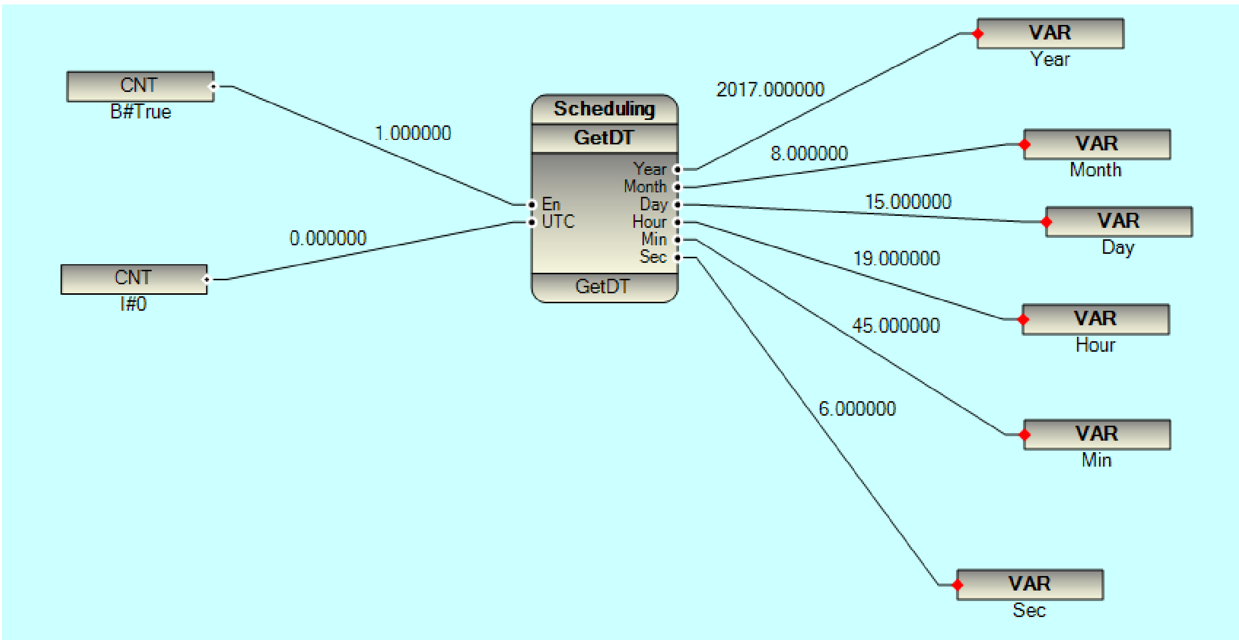


LOG: These functions compute e (the base of natural logarithms) raised to the power I



Scheduling:

GetDT: These Function Shows Current Date and Time of RTU



If En = False , all Outputs are zero

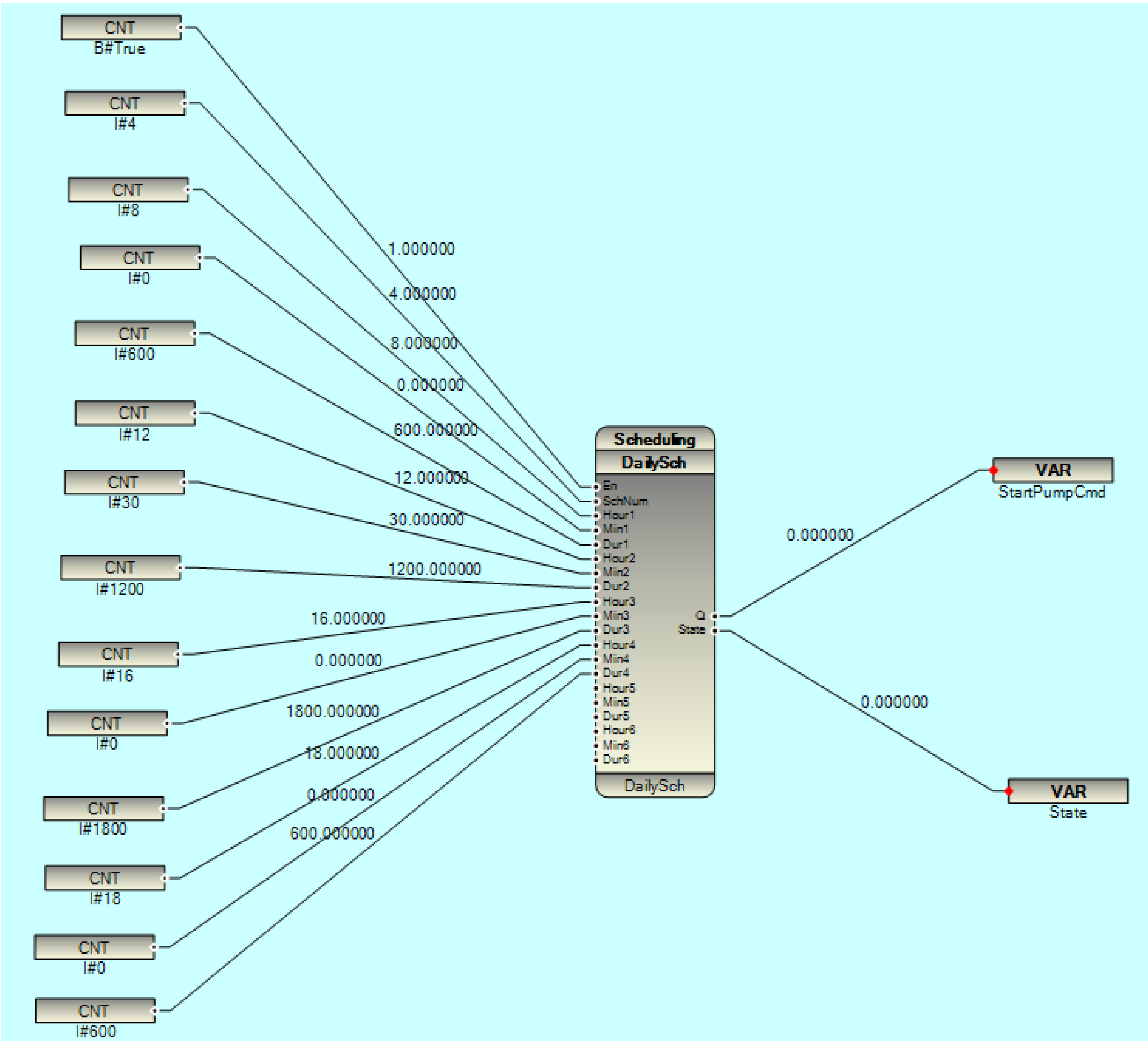
If UTC = 0 , Output DT is in local time

If UTC = 1 , Output is in UTC Time

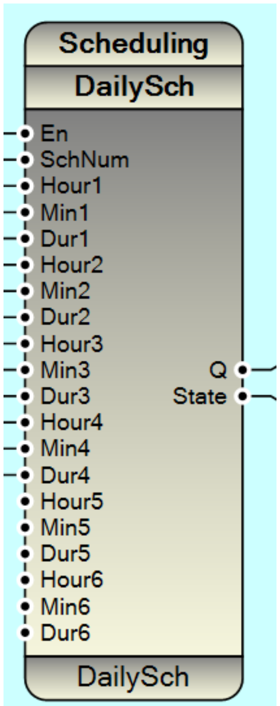
DailySch : These Function is used for daily scheduling of Output . Suppose you want to start an irrigation pump daily with following scheduling:

- 08:00 start Pump for 10 Min
- 12:30 start Pump for 20 Min
- 16:00 Start Pump for 30 Min
- 18:00 Start Pump for 10 Min

Then you can use Dailysch function with following parameters:


CNT
B#True
CNT
I#4
CNT
I#8
CNT
I#0
CNT
I#600
CNT
I#12
CNT
I#30
CNT
I#1200
CNT
I#16
CNT
I#0
CNT
I#1800
CNT
I#18
CNT
I#0
CNT
I#600
1.000000
4.000000
8.000000
0.000000
600.000000
12.000000
30.000000
1200.000000
16.000000
0.000000
1800.000000
18.000000
0.000000
600.000000
Scheduling
DailySch
En
SchNum
Hour1
Min1
Dur1
Hour2
Min2
Dur2
Hour3
Min3
Dur3
Hour4
Min4
Dur4
Hour5
Min5
Dur5
Hour6
Min6
Dur6
Q
State
DailySch
0.000000
VAR
StartPumpCmd
0.000000
VAR
State

Dailysch has following Input /Outputs :



Inputs :

En : Enable /Disable Function Block .

SchNum : Number of Scheduling per day . maximum you can define 6 Schedule .

Hourx : scheduling Number x Start Hour

Minx : scheduling Number x Start Min

Durx :Scheduling Number x Duration time in Sec

Outputs :

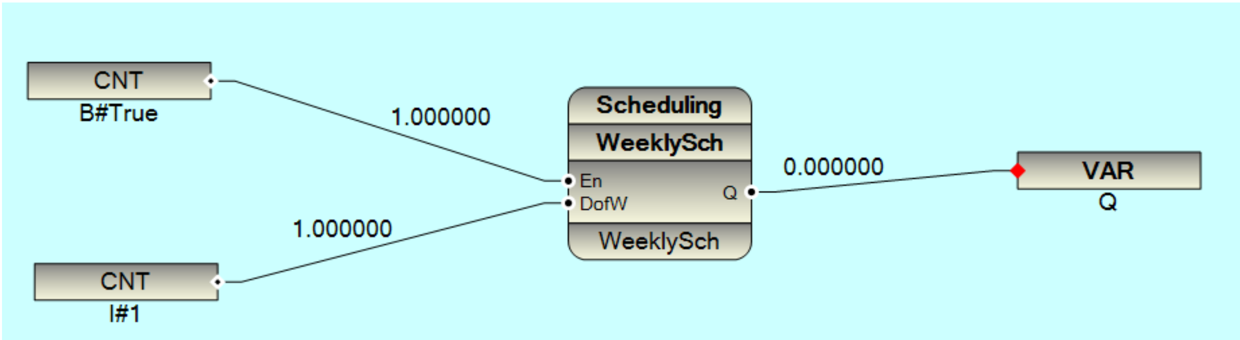
Q : Main Output of FB . You can connect this signal to Pump Management FB .

State : State signal . Internal Usage .

DailySch Function will check current Time in RTU and if it is found time for any Scheduling Time , It will make output High for Duration time .

WeeklySch

These Function check current day of week and set Q if it is same as DofW (Day of Week)

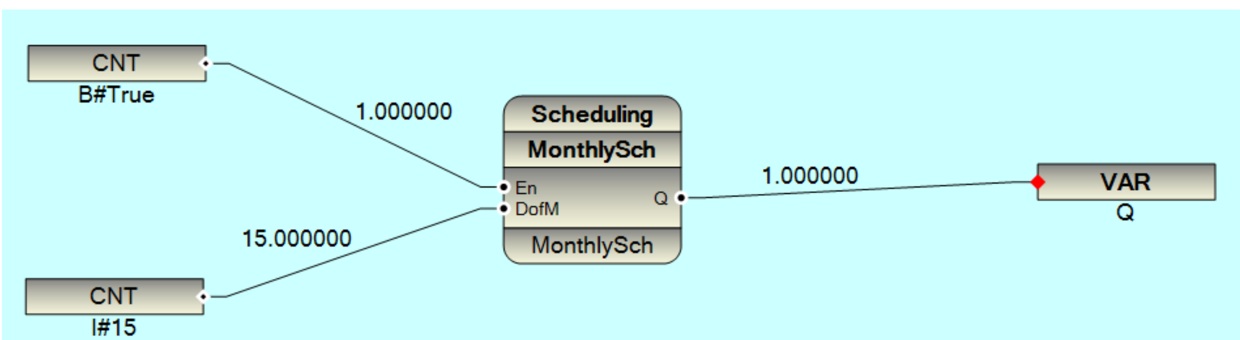


DofW is between 0 (Sunday) to 6 .

You can use WeeklySch with DailySch to make different Scheduling for every day of week .

MonthlySch

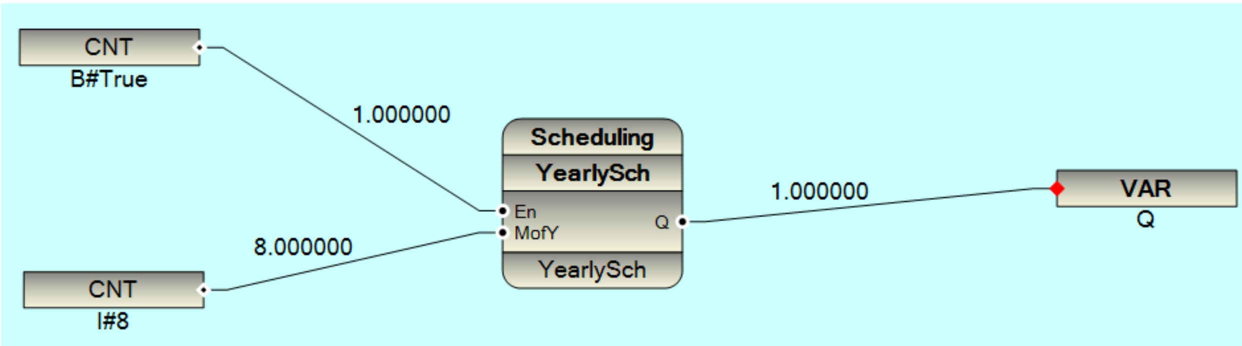
These Function check current day of month and set Q if it is same as DofM (Day of Month)



DofM is integer number between 1 and 31 .

YearlySch

These Function check current Month with MofY (Month of Year) , if it is same as MofY Q Output will set to high .



You can use YearlySch and Monthlysch with DailySch to make different scheduling based on different seasons .