

Connecting PLC device with VC Premium via KepServerEx.

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Introduction

Visual Components OPC UA connection plugin:

The OPC UA connection plugin implements an OPC UA client that can be used to connect to OPC UA servers. Not all features of the quite massive OPC UA standard are supported by the connection plugin implementation, and it hasn't been certified or even tested by any external authority. However, the implementation is based on OPC UA .NET Client SDK from Unified Automation, which is a mature product and is assumed to be standard compliant and generally well made since Unified Automation is a specialized expert company in OPC communications.

KEPServerEX:

KEPServerEX is the industry's leading connectivity platform that provides a single source of industrial automation data to all of automation applications. The platform design allows users to connect, manage, monitor, and control diverse automation devices and software applications through one intuitive user interface. KEPServerEX leverages OPC (the automation industry's standard for interoperability) and IT-centric communication protocols (such as SNMP, ODBC, and web services) to provide users with a single source for industrial data.

KEPServerEX provides access to client applications (like MES and SCADA) and IoT and Big Data analytics software via OPC, proprietary protocols (including GE NIO, SuiteLink/FastDDE, and Splunk), IT protocols (including MQTT, REST, ODBC, and SNMP), and flow measurement export to common Oil & Gas industry and customized formats. We are going to use the demo version of Kepware for this demonstration.

Kepware offers free demo downloads for all of our software products, including KEPServerEX. Demonstration software is fully functional and only limited in its runtime to 2-hour periods. Channel, Device, and Tag counts are unlimited. Download link –

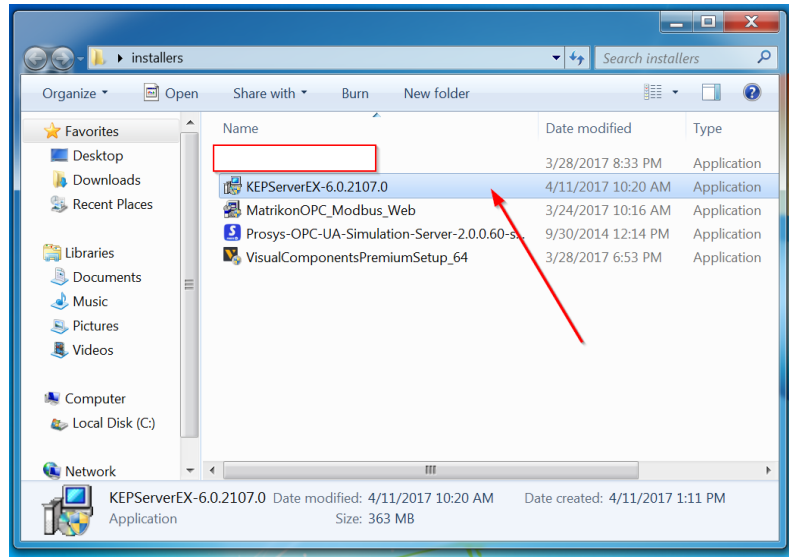
<https://www.kepware.com/en-us/products/kepserverex/>

Connecting KEPServerEX simulation signals to VC Premium

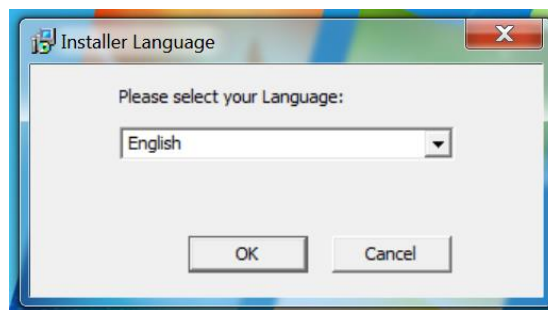
This is the example where the user can test communication of OPC UA connectivity of VC Premium with KepServerEx without having any physical PLC or device connected to KepServer. There are simulation signals in KepServer which are good enough for testing different kinds of data exchange via OPC UA connection e.g. integer, real, string etc.

Step by step installation guide of KEPServerEX in virtual environment (VM Ware)

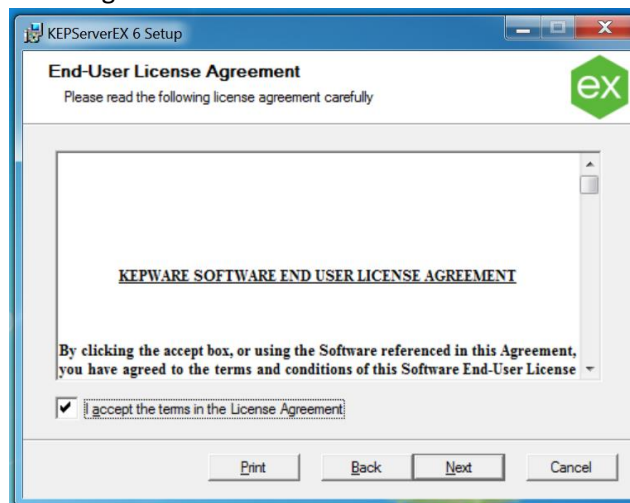
1. Start your VM Ware and then copy your KEPServerEX executable file into some folder.



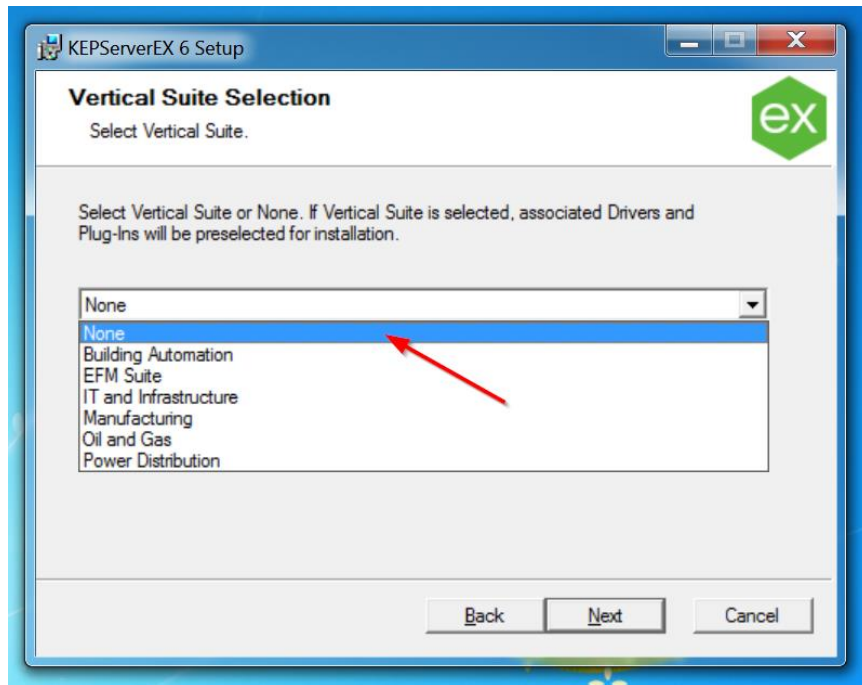
2. Start the installation by double clicking on the installer – [KEPServerEX-6.0.2107.0.exe]
Installation starts and select the language. Here we select [English].



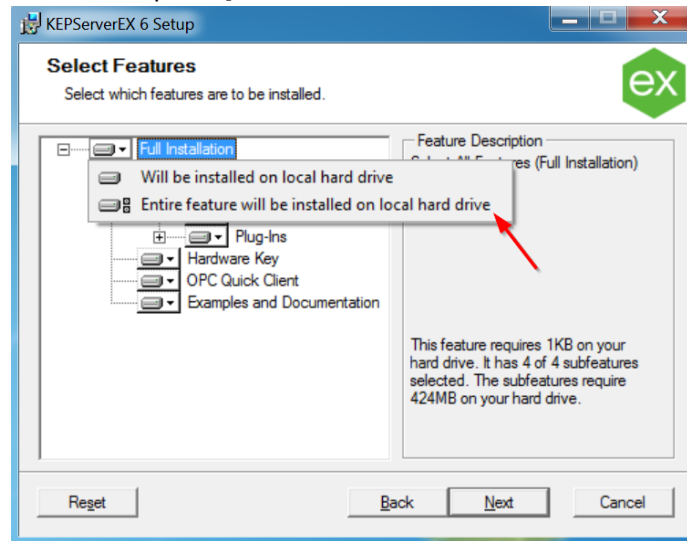
3. Now agree to the term of usage.



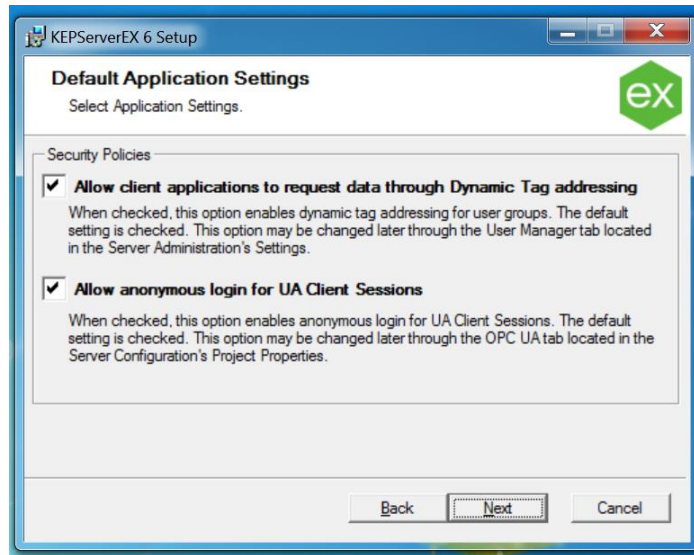
4. Now press Next, Next until you reach the following selection and select (None).



5. Now after this step select the option [Entire features will be installed in local hard drive].



6. Press Next, Next and then Allow both the options below.



7. Press Next button and finish the installation.



Run KEPServerEX as a server

User need to make sure that he can ping from both ways –

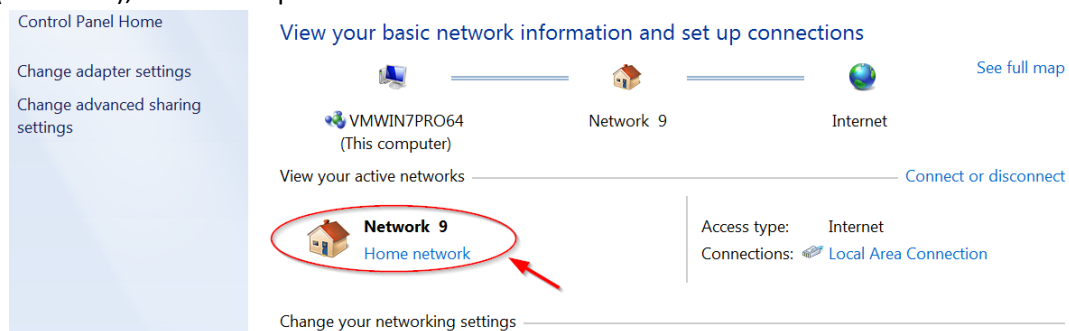
host pc to guest machine i.e. VM Ware

guest machine i.e. VM Ware to host pc.

Go to command prompt (Start > cmd > (press enter)) and write [ipconfig] then press enter. You will get the Ipv4 address of both host pc and guest machine same way. In below screenshot we are getting the IPv4 address of the host machine.

```
Ethernet adapter Ethernet:  
    Connection-specific DNS Suffix  . : VisualComponents.local  
    Link-local IPv6 Address . . . . . : fe80::d0ca:2ec4:3a58:dfc8%13  
    IPv4 Address. . . . . :   
    Subnet Mask . . . . . :   
    Default Gateway . . . . . :   
  
Wireless LAN adapter Local Area Connection* 2:  
    Media State . . . . . : Media disconnected  
    Connection-specific DNS Suffix  . :   
  
Ethernet adapter VMware Network Adapter VMnet1:  
    Connection-specific DNS Suffix  . :   
    Link-local IPv6 Address . . . . . : fe80::8d90:3c70:e26:f754%10  
    IPv4 Address. . . . . :   
    Subnet Mask . . . . . :   
    Default Gateway . . . . . :   
  
Ethernet adapter VMware Network Adapter VMnet8:  
    Connection-specific DNS Suffix  . :   
    Link-local IPv6 Address . . . . . : fe80::b449:fd8f:924f:4bc6%7  
    IPv4 Address. . . . . :   
    Subnet Mask . . . . . : 
```

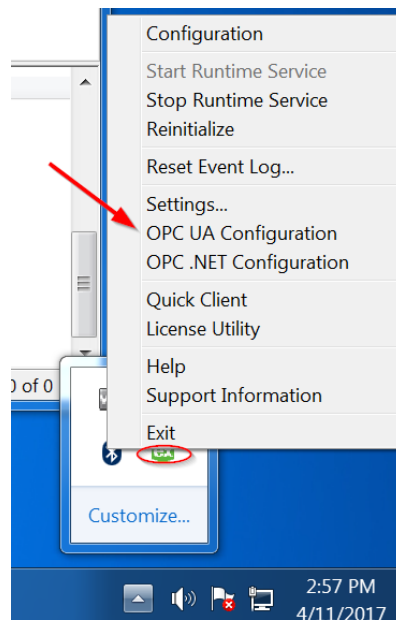
There is most probably going to be issues while pinging from host machine to guest machine (VM Ware), in this case please set the network connection of VM Ware into Home Network.



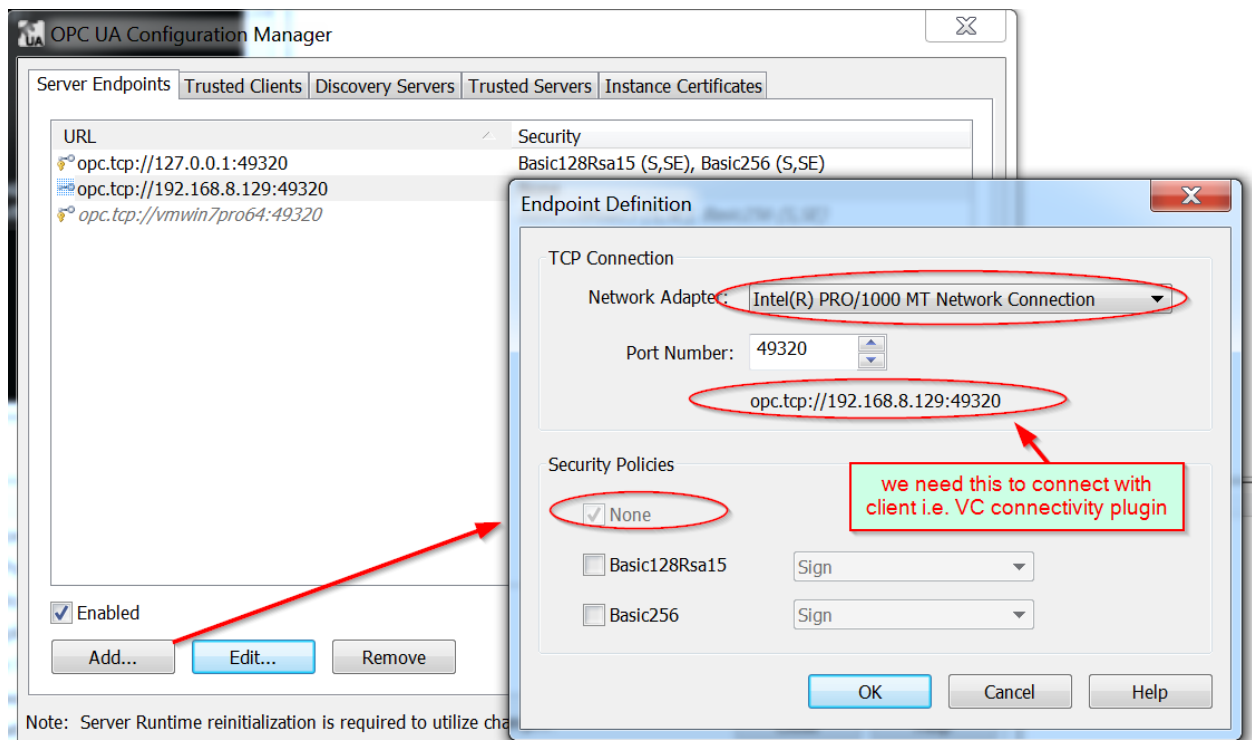
An example of successful ping from host machine to guest machine.

```
V:\>ping 192.168.8.129  
  
Pinging 192.168.8.129 with 32 bytes of data:  
Reply from 192.168.8.129: bytes=32 time=5ms TTL=128  
Reply from 192.168.8.129: bytes=32 time<1ms TTL=128  
Reply from 192.168.8.129: bytes=32 time<1ms TTL=128  
Reply from 192.168.8.129: bytes=32 time<1ms TTL=128  
  
Ping statistics for 192.168.8.129:  
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),  
    Approximate round trip times in milli-seconds:  
        Minimum = 0ms, Maximum = 5ms, Average = 1ms  
  
V:\>
```

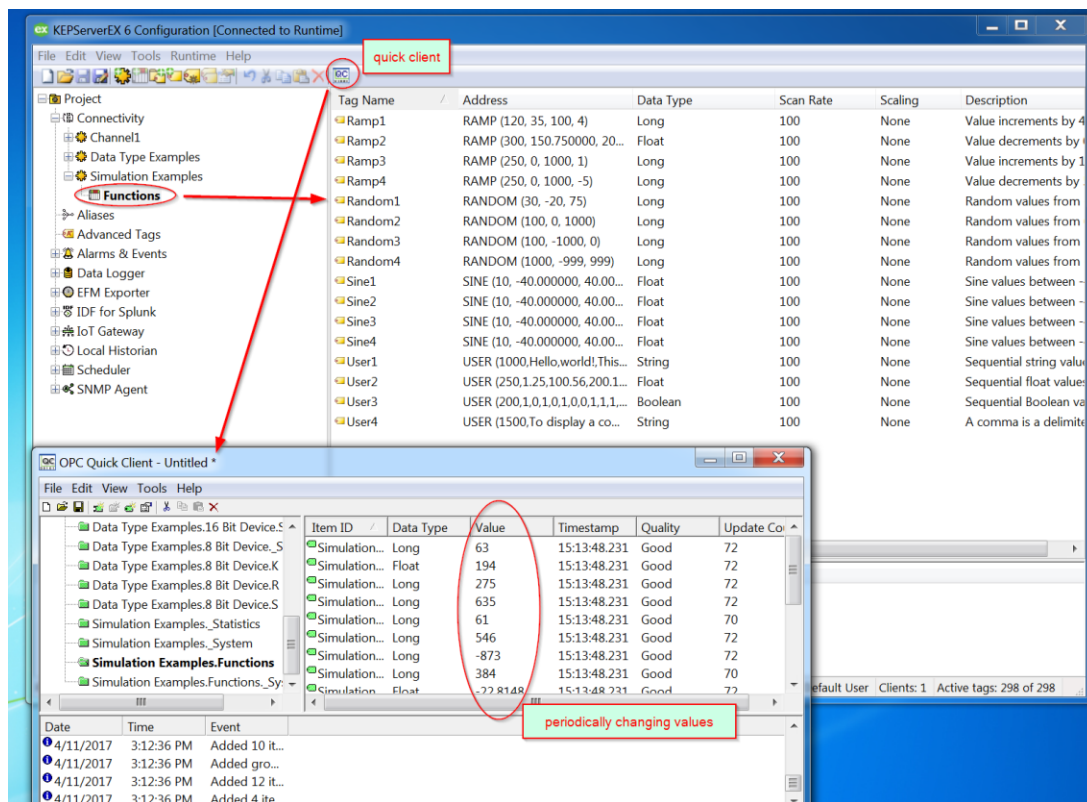
Go to Notification area in bottom right corner of windows and then right click on running application (KEPServerEX) and then select OPC UA Configuration.



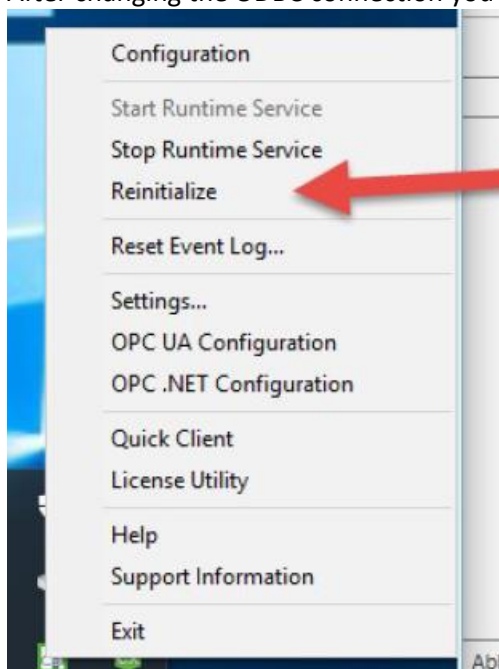
Now press [Add] button to configure a new TCP Connection and there we need to set our own network adapter (in my case it is Intel(R) PRO), then set the port number e.g. 49320, please don't forget to set the security settings as (None) at this stage as we are trying to establish connection with minimum settings. The security settings will come later. The following setup will generate a TCP connection path for the client to establish connection with the Kepware simulation server, in this case it was [opc.tcp://192.168.8.129:49320]



In the project tree inside Simulation Examples > Functions we get some available simulation variables of different data types Float, Long, String, Boolean etc. To see the periodically changing values we need to click on the button on top (Quick Client). This shows the simulating values.

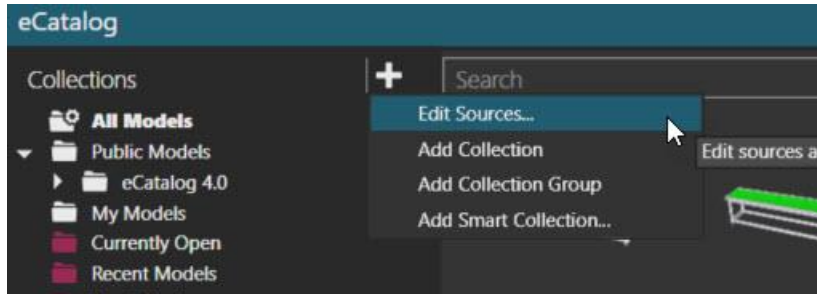


After changing the ODBC connection you have to press Reinitialize.

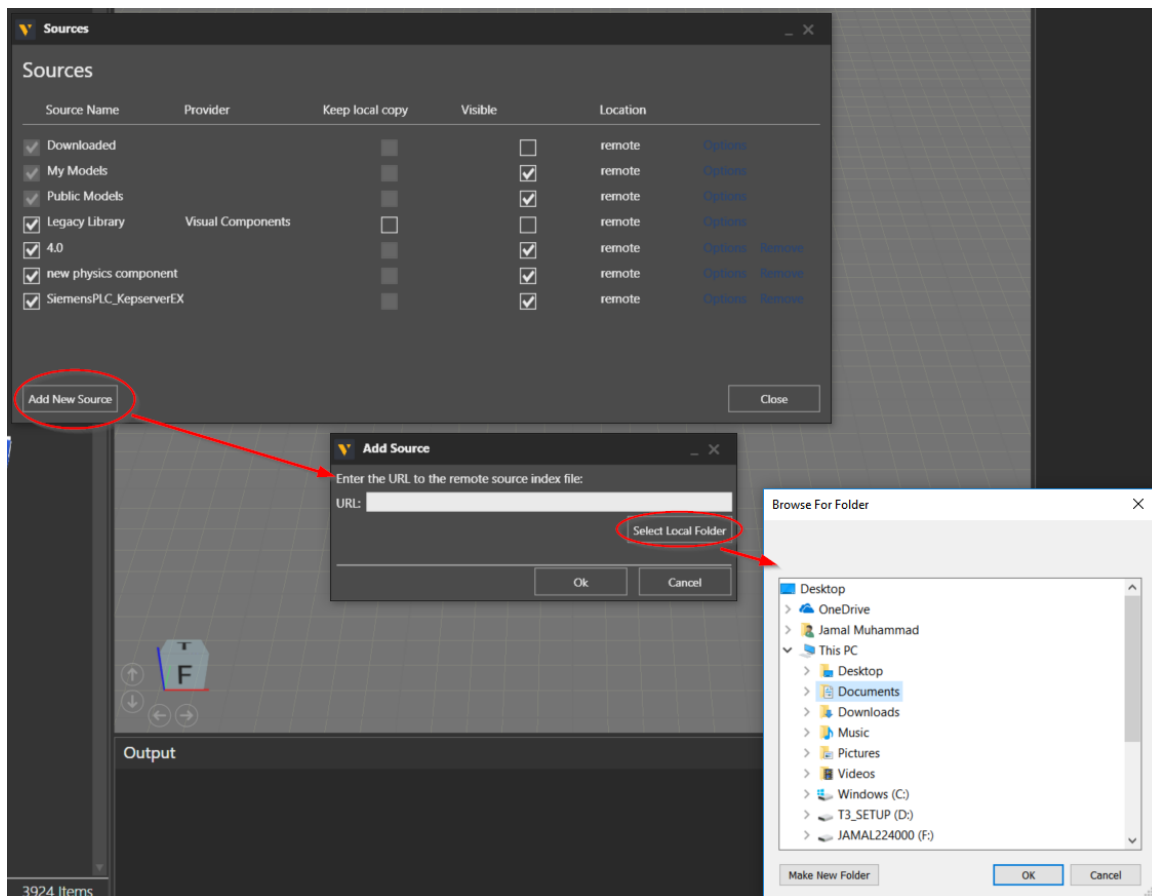


Working with VC connectivity plugin (Client side)

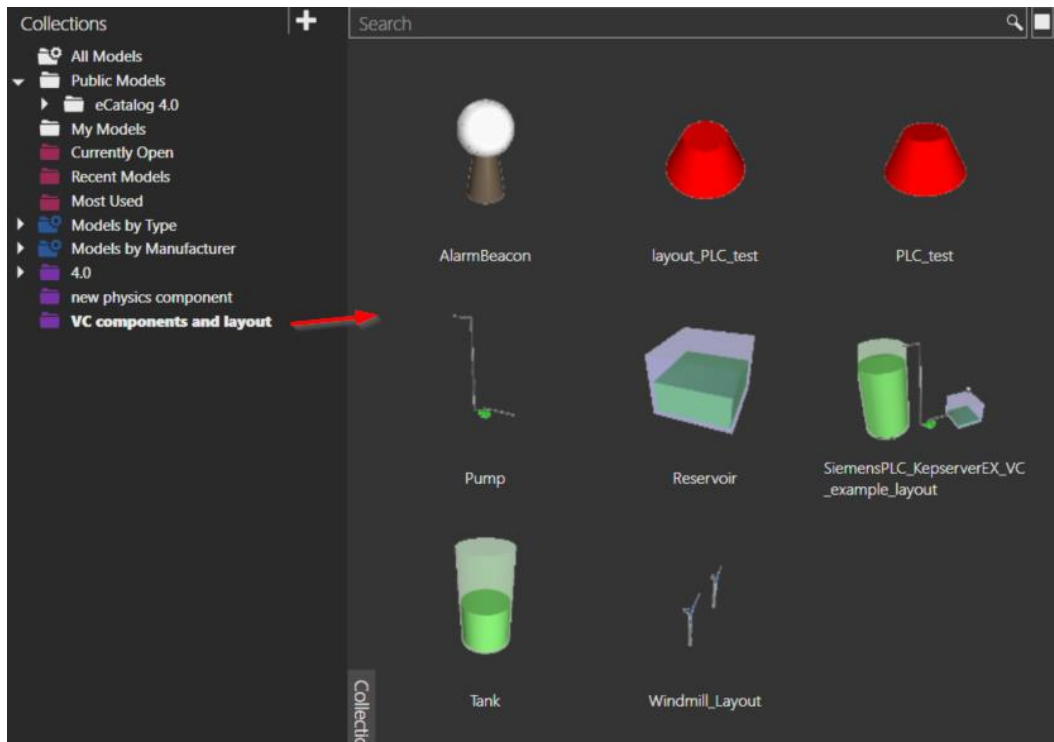
Attach the folder [VC components and layout] in the local eCat of VC Premium. Left click on the (+) sign and then select [Edit Source]



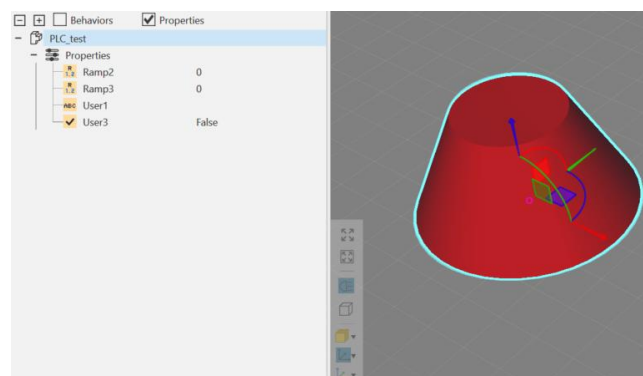
Now select the folder which is [VC components and layout]



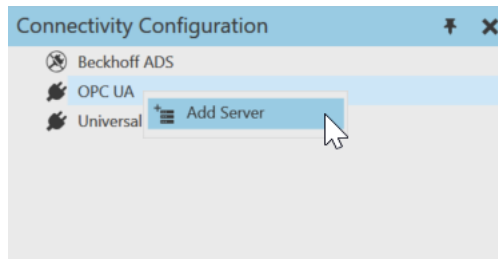
When added the local eCat will show the thumbnails of the components and layouts in the folder.



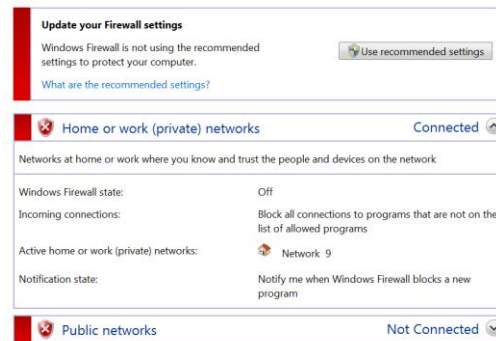
1. Open VC Premium and then load the attached component [PLC_test.vcmx]
2. In this component there are 4 variables defined already and those are –
 - Ramp2 > Float
 - Ramp3 > Long
 - User1 > String
 - User3 > Boolean



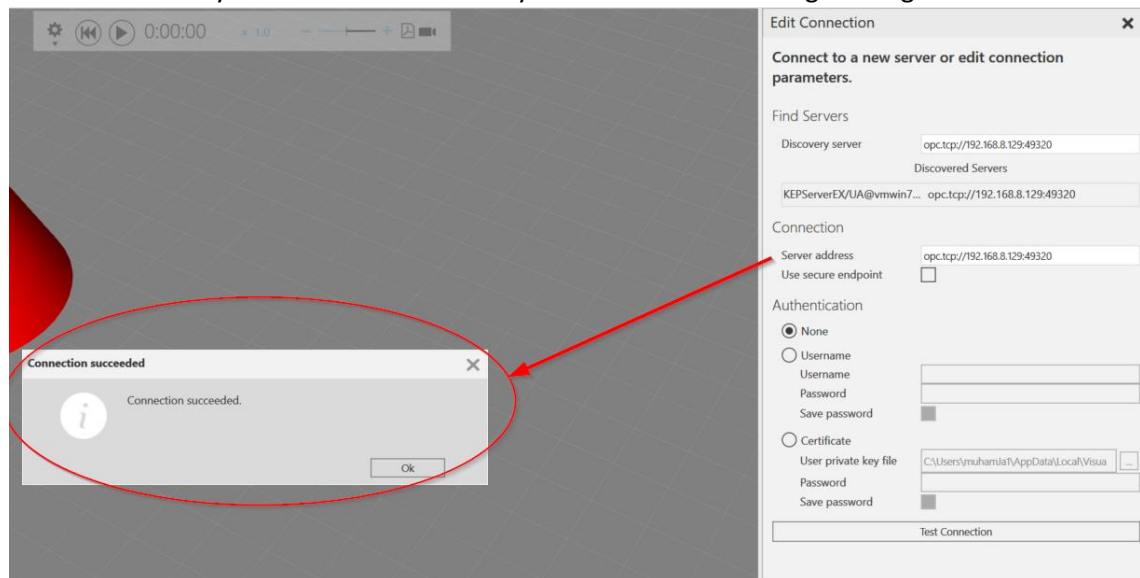
3. Go to Connectivity Tab and then select OPC UA > Add Server.



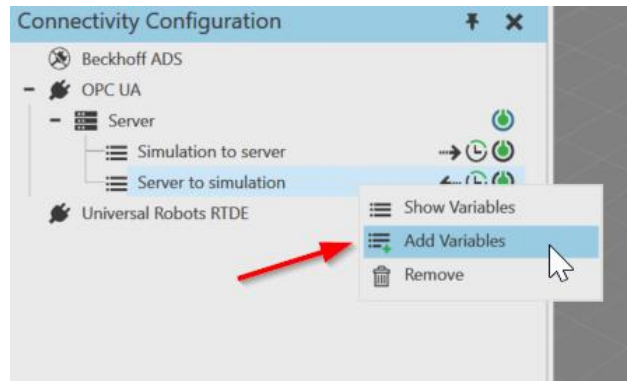
4. Remember the TCP address we got from the Kepware server. It was [opc.tcp://192.168.8.129:49320] .
Now we put this address into the following slot and then test connection. If connection fails then turn the Windows Firewall OFF of the Virtual machine operating system.



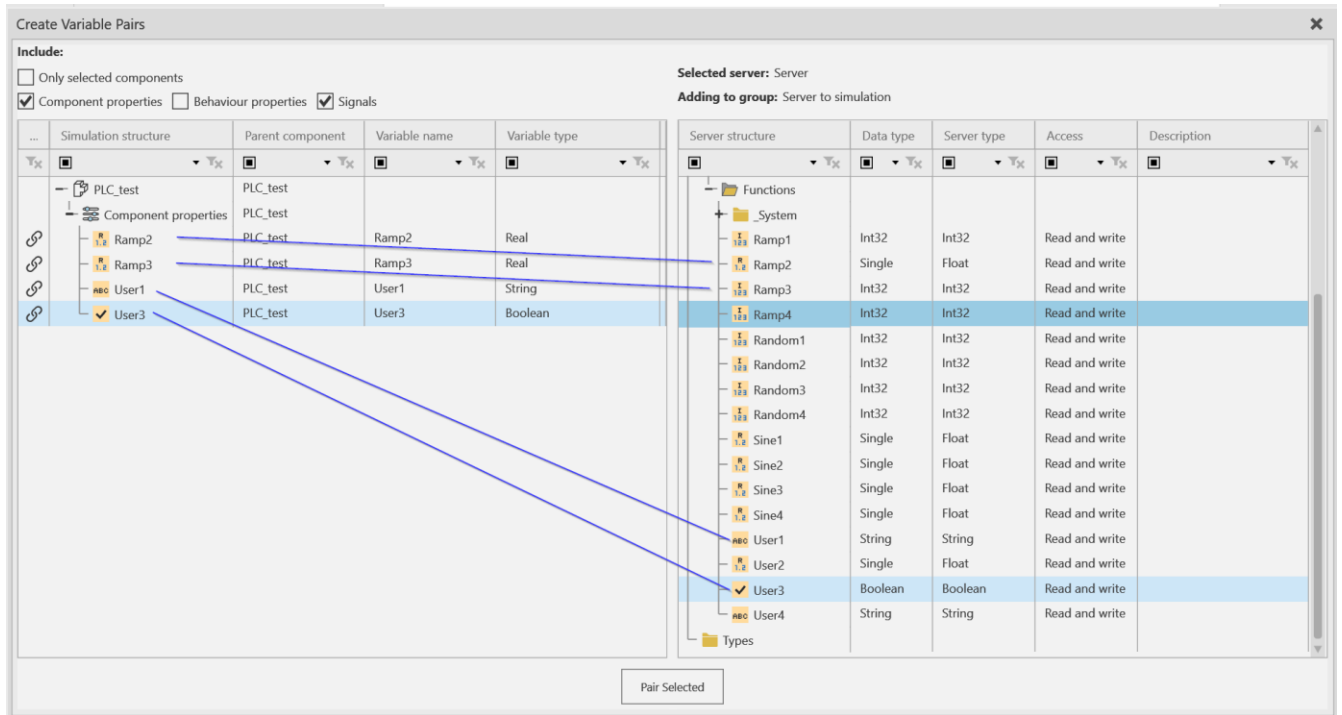
5. When successfully connection established you will see the following message.



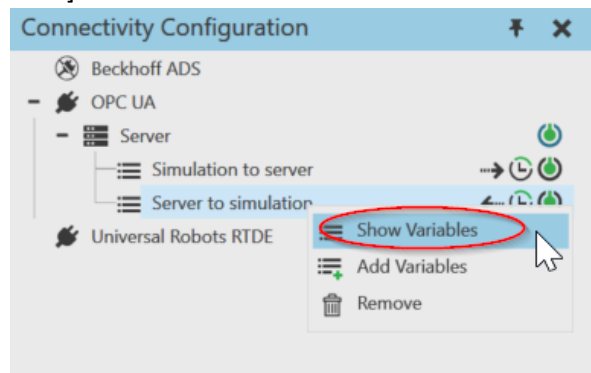
6. Now we need to connect the server and then we need to select Simulation to server (right click) > Add Variables



7. Now need to connect the variables of simulation with the server variables as shown below.



8. After the connection has been established we can right click on (Server to simulation) and then click [Show Variables]



9. This will show up the Connected Variables ribbon as following.

Connected Variables							
Structure	Simulation variable	...	Simulati...	Prepared...	Latest va...	...	Server variable
Server							
Simulation to server							
Server to simulation							
Ramp2	PLC_test.Ramp2	1.2	0			?	Ramp2
Ramp3	PLC_test.Ramp3	1.2	0			?	Ramp3
User1	PLC_test.User1	ABC				?	User1
User3	PLC_test.User3	✓	FALSE			?	User3
							Float
							Int32
							String
							Boolean

10. Now finally we can press the [Simulate] button and see the values of the connected variables changing (in Simulation) as per feed from the Kepware simulation server.

The screenshots show the 'Connected Variables' window in Visual Components Premium 4.0. The window displays a table of variables and their values during simulation. The 'Server to simulation' connection is active and enabled. The 'Connected Variables' window shows the following data:

Structure	Simulation variable	Simulation value	Pre...	Latest val...	Sta...	Server varia...	Server type
Server							
Simulation to server							
Server to simulation							
Ramp2	PLC_test.Ramp2	158.25		158.25	✓	Ramp2	Float
Ramp3	PLC_test.Ramp3	346		346	✓	Ramp3	Int32
User1	PLC_test.User1	Hello		Hello	✓	User1	String

The 'Properties' window on the right shows the 'Server to simulation' connection settings. The 'Name' is 'Server to simulation', 'Active' is 'True', 'Enabled' is checked, 'Transmit d...' is 'Server to simulation', 'Update m...' is 'Cyclic', 'Cyclic upd...' is '50', 'Delay war...' is '100', 'Delay erro...' is '5000', and 'Value max...' is '1'.

Setting up security certificate

To identify itself to communication partners, each installed OPC UA application or devices needs an Application Instance Certificate and an associated public/private key pair. The public key is distributed with the certificate. The private key has to remain secret and is used to sign and/or encrypt messages. A communication partner can use the public key to verify the trust relation, check the signature of messages, and encrypt messages. The Application Instance Certificate, including the public and private key, can either be generated by the application or provided by an administrator.

Certificates are filed in a Certificate Store, containing separate locations for trusted and own certificates, as well as certificates from certificate authorities used to verify certificate chains. An additional rejected location may contain certificates of applications that tried to connect but are not trusted yet.

Certificates issued by the application are called self-signed certificates. They are typically generated during installation of the application or at first start. To establish a trust relation between an OPC UA client and server, the self-signed certificates of the communication partner are installed to the trust list. The client certificate is installed to the trust list of the server and the server certificate to the trust list of the client. If the certificate of an application is removed from the trust list, a communication establishment is no longer possible.

More information:

http://documentation.unified-automation.com/uasdkhp/1.0.0/html/_12_ua_discovery_connect.html

The security certificate file (Client) [Opc.Ua.CertificateGenerator.exe] is attached here with the instruction package. Copy and then paste the file to the installation folder of the Visual Components software, usually it's here:

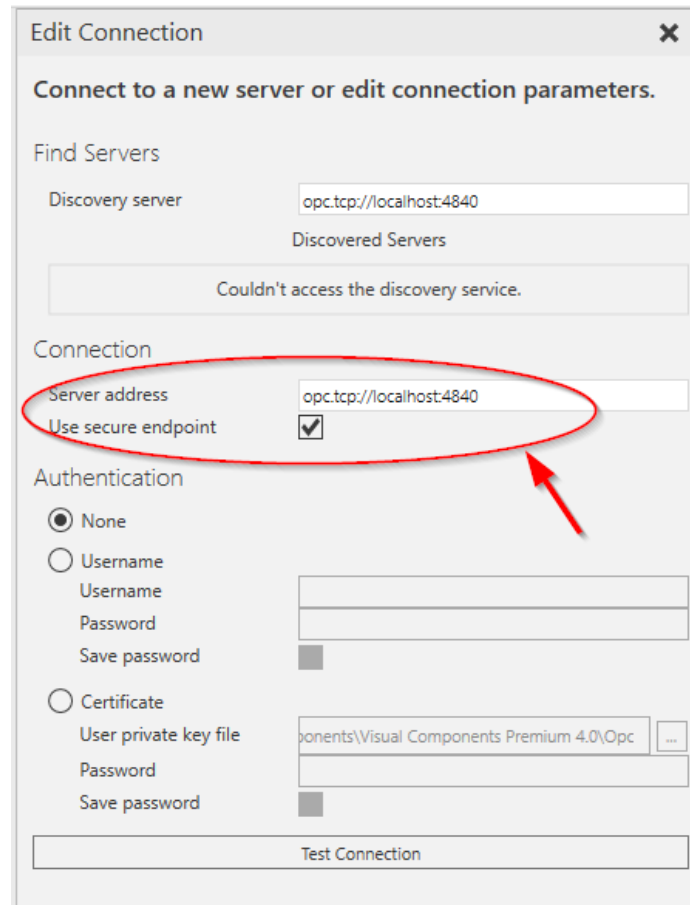
C:\Program Files\Visual Components\Visual Components Premium 4.0

Then re-start VC software. Now the user can go check that the security trust certificates has been created in the following locations:

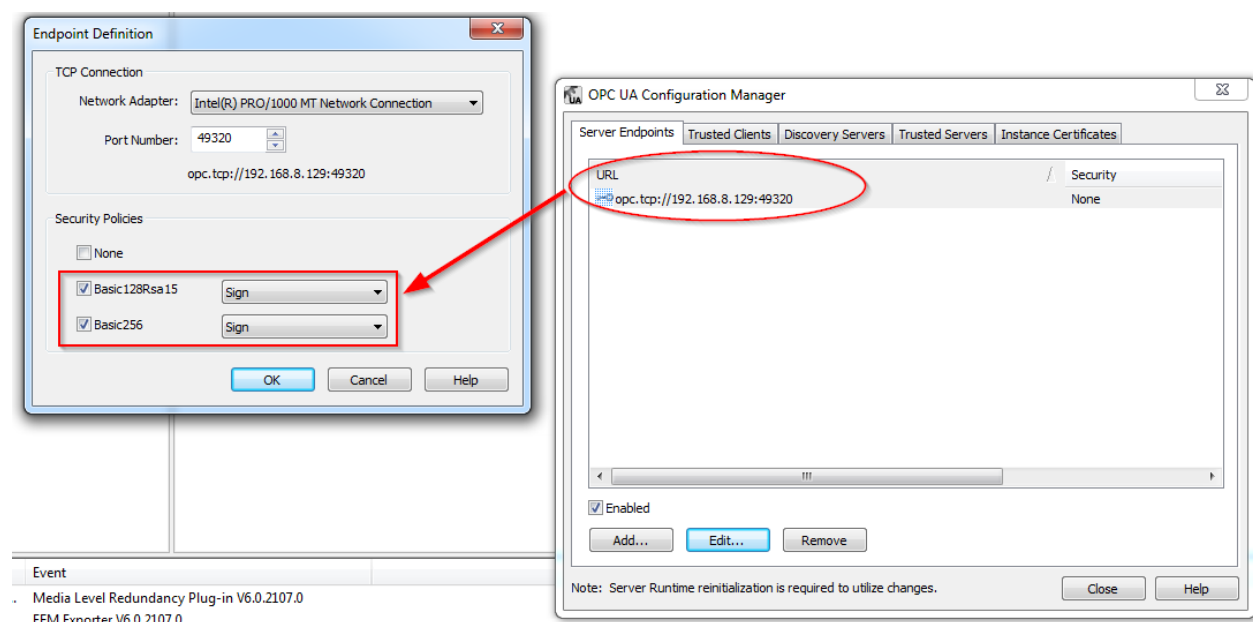
C:\Users\muhamJa1\AppData\Local\Visual Components\Visual Components Premium 4.0\OpcUA\own\certs

C:\Users\muhamJa1\AppData\Local\Visual Components\Visual Components Premium 4.0\OpcUA\trusted\certs

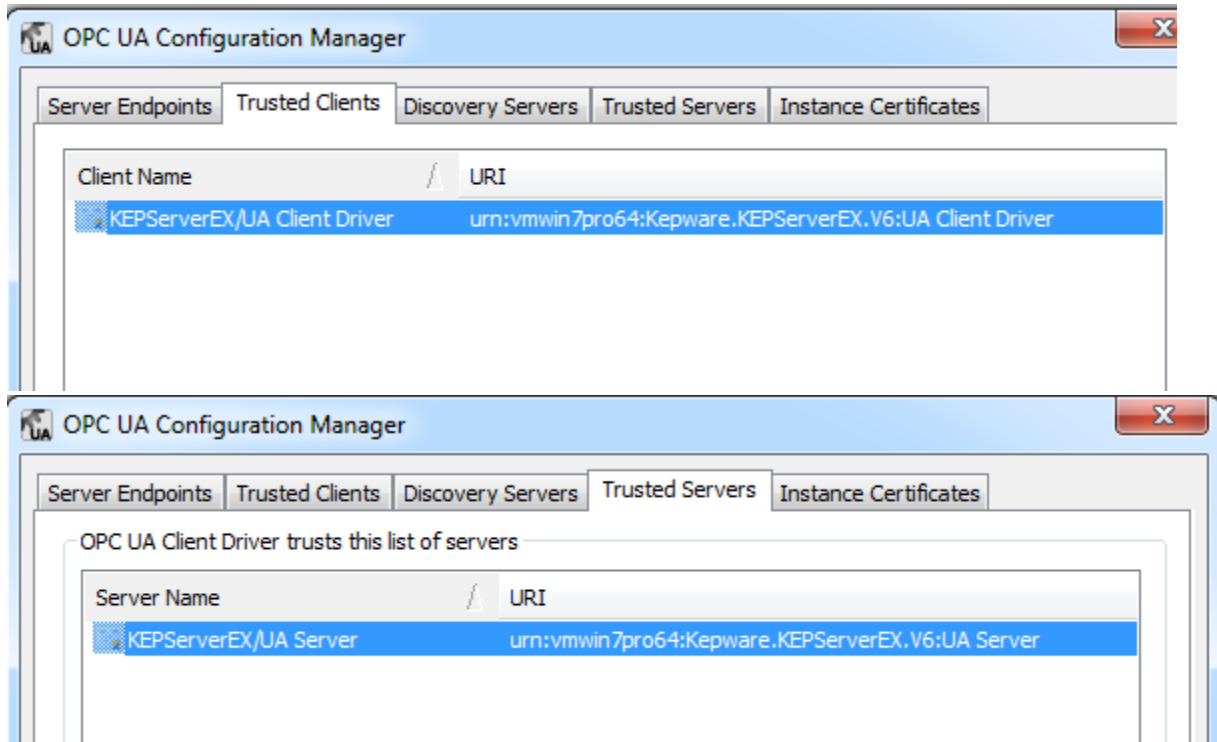
After this stage while communicating with OPC UA server the user can select the option [Use secure endpoint]



Now when we go to the server side in the virtual machine i.e. VM Ware now we can set-up the secure endpoint connection application. Please look the OPC UA Configuration Manager Screenshot below, now the Security Policy Is instead of [None] is set to [Basic128Rsa15] & [Basic256].



See the files generated under the sections [Trust Clients] and [Trusted Servers] in the OPC UA Configuration Manager. After establishment of client-server connection these files will be visible.



Connecting physical PLC signals via KepServerEx to VC Premium

This example is helpful for the people who has real physical PLC and would like to test the OPC UA connectivity feature of VC Premium. For this example Siemens S7 1214 AC/DC PLC used.

Siemens TIA portal & PLC Hardware/Software setup

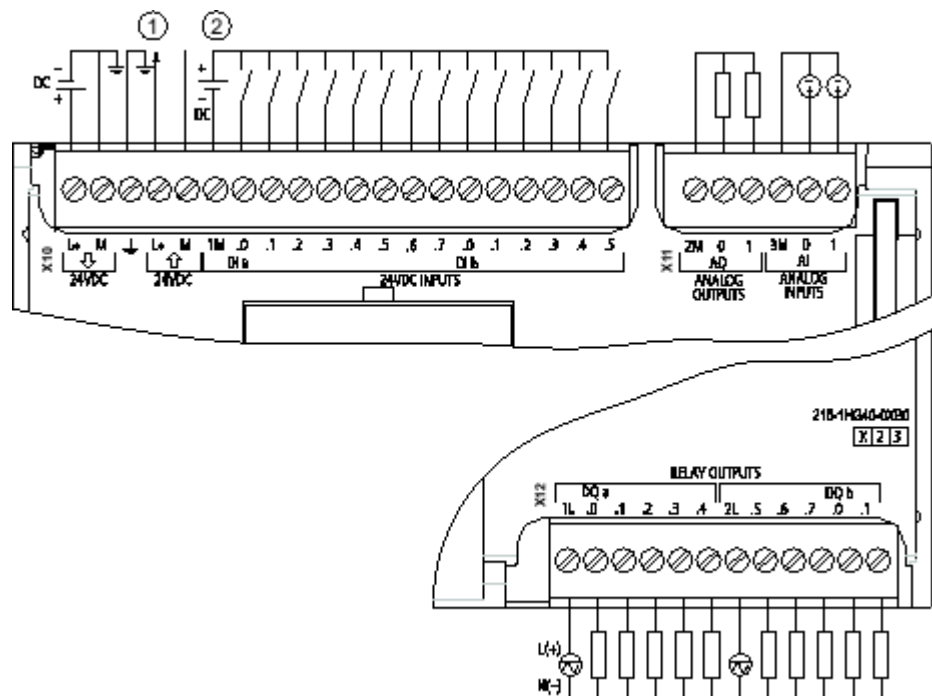
For this project Siemens TIA portal V13 Basic edition was used. The Hardware used is S7 1214AC/DC PLC and additional IO card i.e AI 4x13BIT/AQ 2x14BIT_1. Details of the devices used -

PLC > 1214 AC/DC PLC

- Digital Input – 14
- Digital Output – 10
- Analog Input – 2

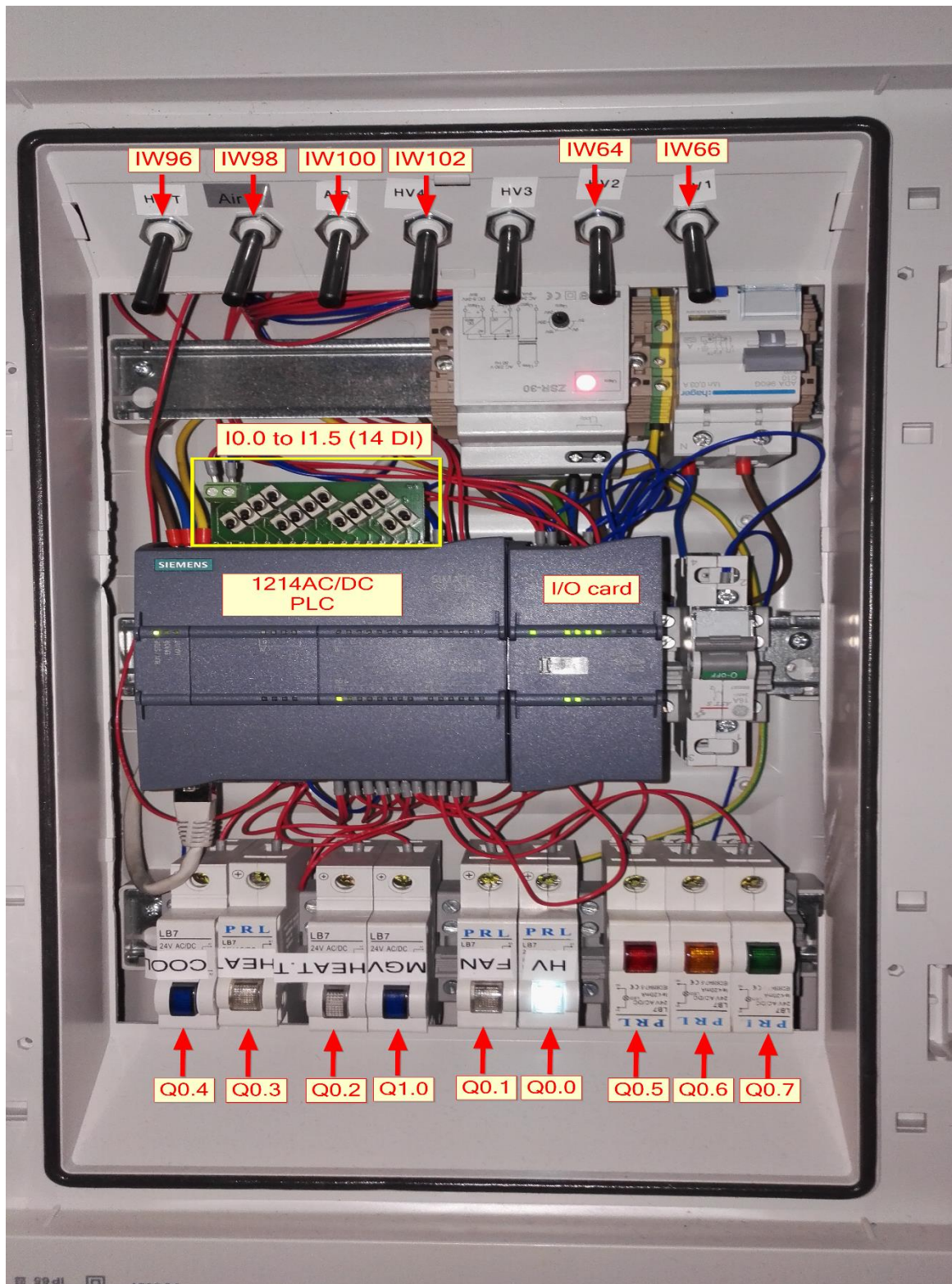
IO card > AI 4x13BIT/AQ 2x14BIT_1

- Analog Input – 4
- Analog Output – 2

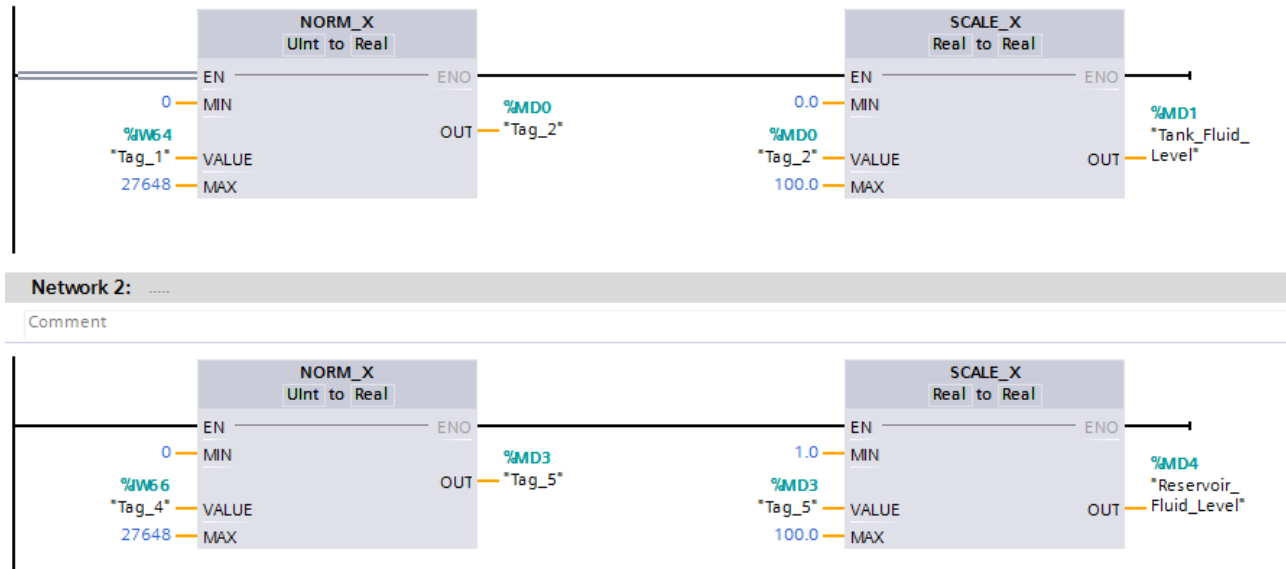


- Digital input address space – I0.0, I0.1, I0.2, I0.3, I0.4, I0.5, I0.6, I0.7, I1.0, I1.1, I1.2, I1.3, I1.4, I1.5
- Digital output address space – Q0.0, Q0.1, Q0.2, Q0.3, Q0.4, Q0.5, Q0.6, Q0.7, Q1.0, Q1.1
- Analog input address space – IW64, IW66
- IO extension card analog input address – IW96, IW98, IW100, IW102
- IO extension card analog output address – QW96, QW98

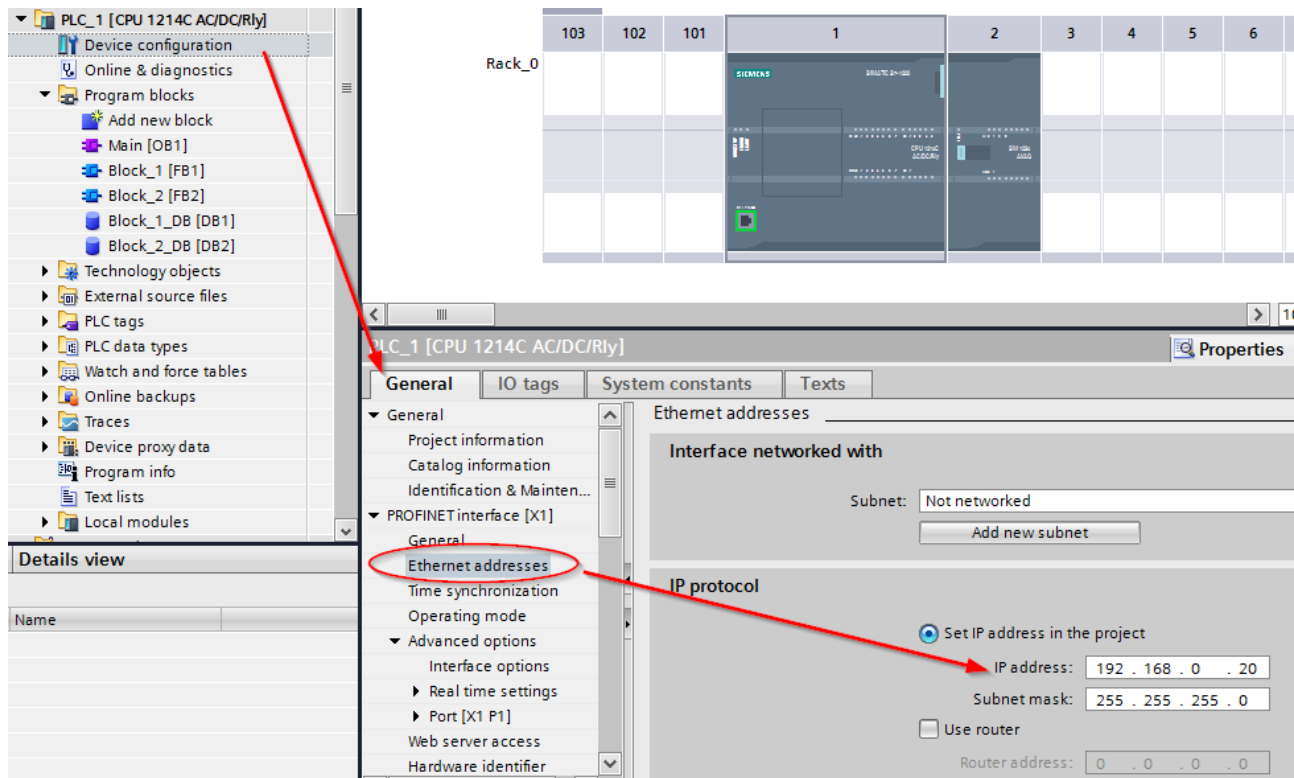
Below picture depicts the actual hardware wiring of the PLC with the test bench.



Now open the attached PLC program project [Project_KepserverEX_connection.ap13] in TIA portal. The PLC program is there. As PLC Ladder programming is not within the scope of this instruction file so we are not going to discuss PLC Ladder programming. Although as it is important to know how to read in analog signal here is the analog input signal reading ladder program from address space IW64 and IW66-



Check the Ethernet TCP/IP address setting of PLC device from the following place-



Connect the PLC to PC and then after checking the TCP/IP address of the PC's Ethernet port make sure that they are in same subnet and they are not the same (they should not conflict), now the user can compile and download the PLC program to the PLC device.

The main logic of the PLC program are very simple. We have 2 layouts -

1) SiemensPLC_KepserverEX_VC_example_layout.vcmx

a. when we increase the input value of IW64 then the connected Tank fluid level in simulation will increase, and when IW64 value decrease the Tank fluid level will decrease.

b. when we increase the input value of IW66 then the connected Reservoir fluid level in simulation will increase, and when IW66 value decrease the Reservoir fluid level will decrease.

c. when IW64 value goes below 90 then the pump starts to run i.e. Q0.0, otherwise pump is OFF.

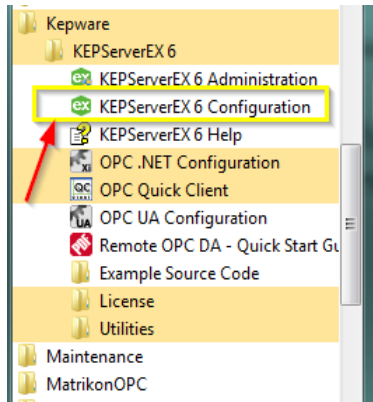
d. when IW66 value goes below 10 then the level alarm signal Q0.1 goes ON and the Alarm Beacon starts to simulate in simulation.

2) windmill_PLC.vcmx

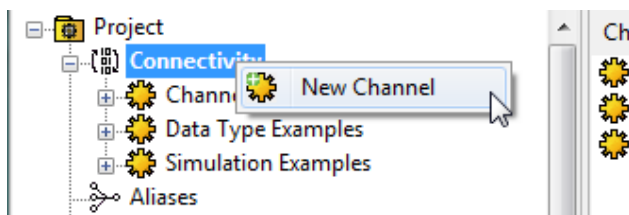
a. when we increase the value of IW96 then the speed of windmill in simulation goes up, when value of IW96 decreases then vice versa happens. To see the effect of speed change the user needs to stop-restart the simulation after every speed change.

Working with KepserverEX6

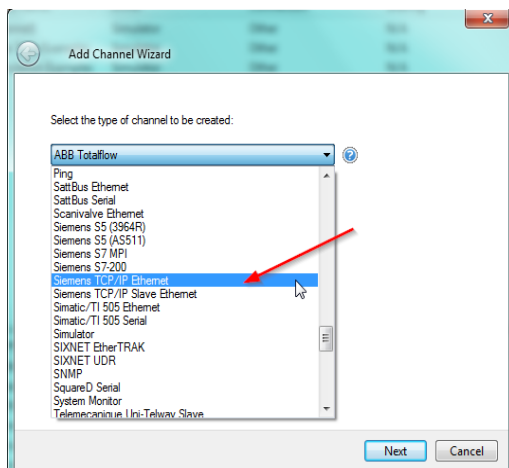
Open Kepserver > Kepware EX6 Configuration from here



Right click on Connectivity and select New Channel



Select (Siemens TCP/IP Ethernet) from dropdown list.



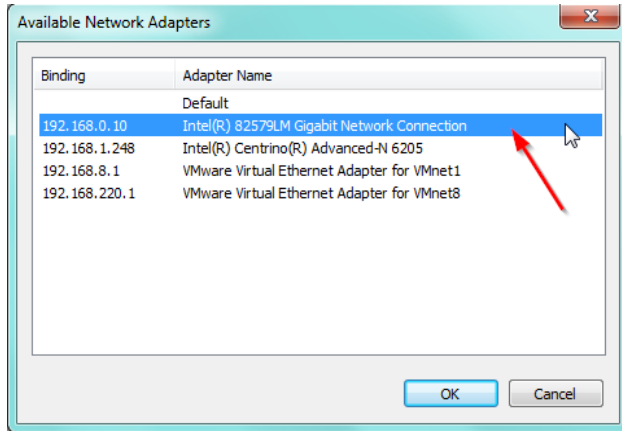
Now name the connection as (Siemens_Connection) or something which suits you.

Specify the identity of this object.

Name:

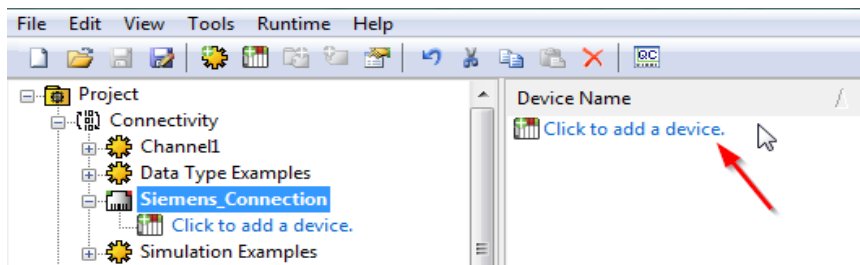
Siemens_Connection

Select Network Adapter



Press Next > Next and finally Finish.

Now we need to add the specific PLC to our KepServer. Click on the [Click to add a device]



Now name the PLC device

Specify the identity of this object.

Name:

S7_1214c

Select the device, for this example the device family is S7 1200

Select the specific type of device associated with this ID. Options depend on the type of communications in use.

Model:

S7-1200

Now select the TCP/IP address of the PLC Device

Specify the device's driver-specific station or node.

ID:

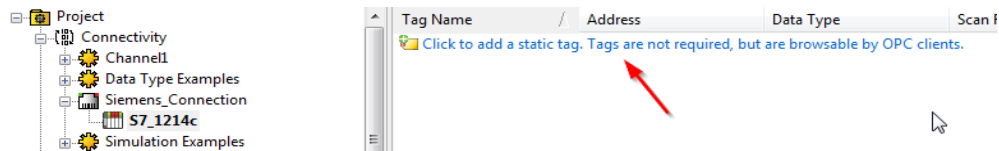
192.168.0.20



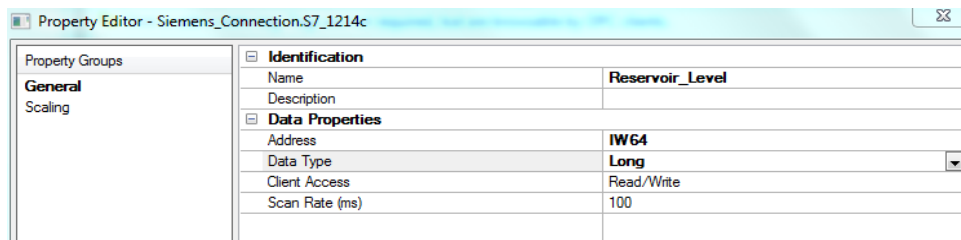
Now after pressing next several times with default settings finally finish the setup of PLC.

Identification	
Name	S7_1214c
Description	
Channel Assignment	Siemens_Connection
Driver	Siemens TCP/IP Ethernet
Model	S7-1200
ID	192.168.0.20
Operating Mode	
Data Collection	Enable
Simulated	No
Scan Mode	
Scan Mode	Respect Client-Specified Scan Rate
Initial Updates from Cache	Disable
Communication Timeouts	
Connect Timeout (s)	3
Request Timeout (ms)	2000
Retry Attempts	2
Timing	
Inter-Request Delay (ms)	0
Auto-Demotion	
Demote on Failure	Disable
Tag Generation	
On Device Startup	Do Not Generate on Startup
On Duplicate Tag	Delete on Create
Parent Group	
Allow Automatically Generated Subgroups	Enable
Communication Parameters	
Port Number	102
MPI ID	0
S7-200	
Local TSAP	4D57
Remote TSAP	4D57
S7-300/400/1200/1500	
Link Type	PC
CPU Rack	0
CPU Slot	1

To insert Tags now click the following [Click to add static tag...] and add the PLC I/O tags as per address space defined in the PLC. Better to have the tag names similar as the the PLC tag names in PLC so it's easier to pair later in simulation software.

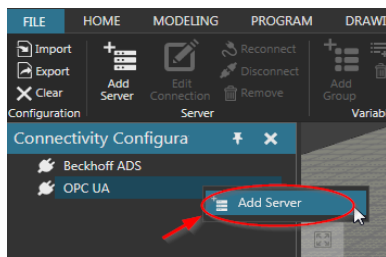


One example of Tag insertion (analog signal input to PLC)

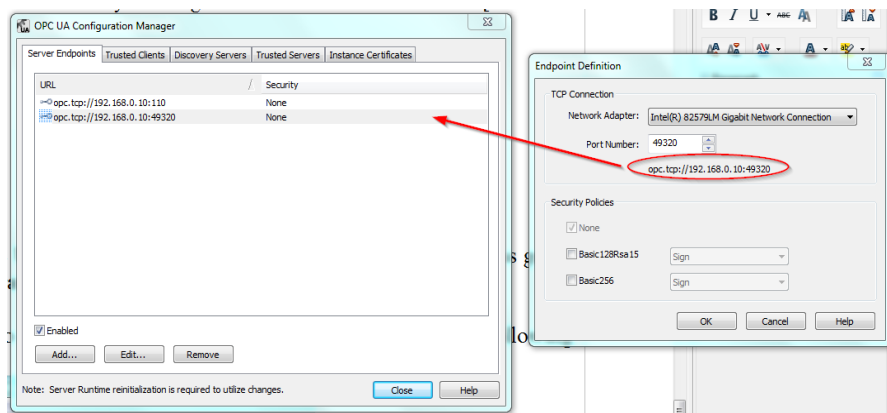


Connect VC Premium with KepserverEX

Open VC Premium and turn ON the connectivity tab. Right click on OPC UA and select [Add Server].



Connect to server by using the OPC UA server connection settings. To see the server address go to KEPServerEX > OPC UA Configuration.



Now Connect the KEPServerEx into Runtime mode and make sure you have defined the following tags into the KEPServer side.

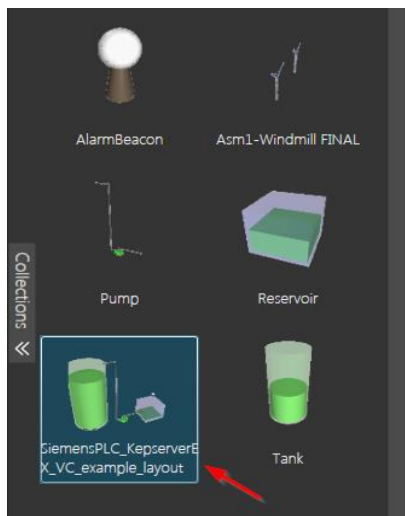
Configuration [Connected to Runtime]

Tools Runtime Help

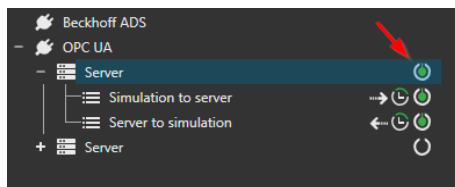
Tag Name	Address	Data Type	Scan Rate	Scaling
Beacon_Status	Q0.1	Boolean	100	None
Pump_Status	Q0.0	Boolean	100	None
Reservoir_Fluid_Level	MD1	Float	100	None
Tank_Fluid_Level	MD4	Float	100	None

Tags

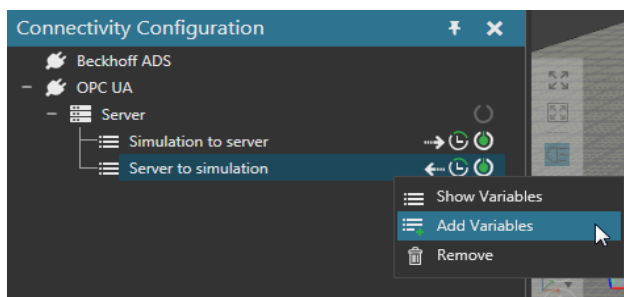
Now load this layout attached with this instruction file set. Name of layout [SiemensPLC_KepserverEX_VC_example_layout.vcmx]











Connect to the server by pressing the Green button next to it.



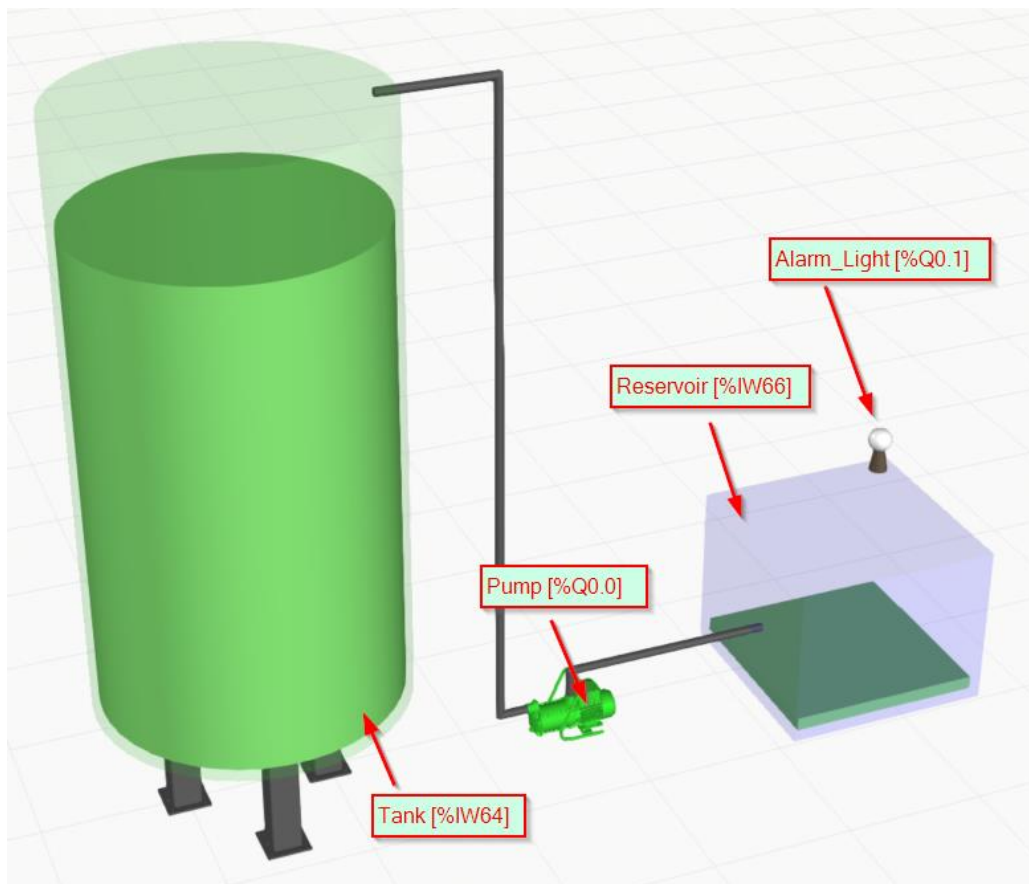
Now in Client side connection i.e PC Premium right click on Server and press [Add Variables]



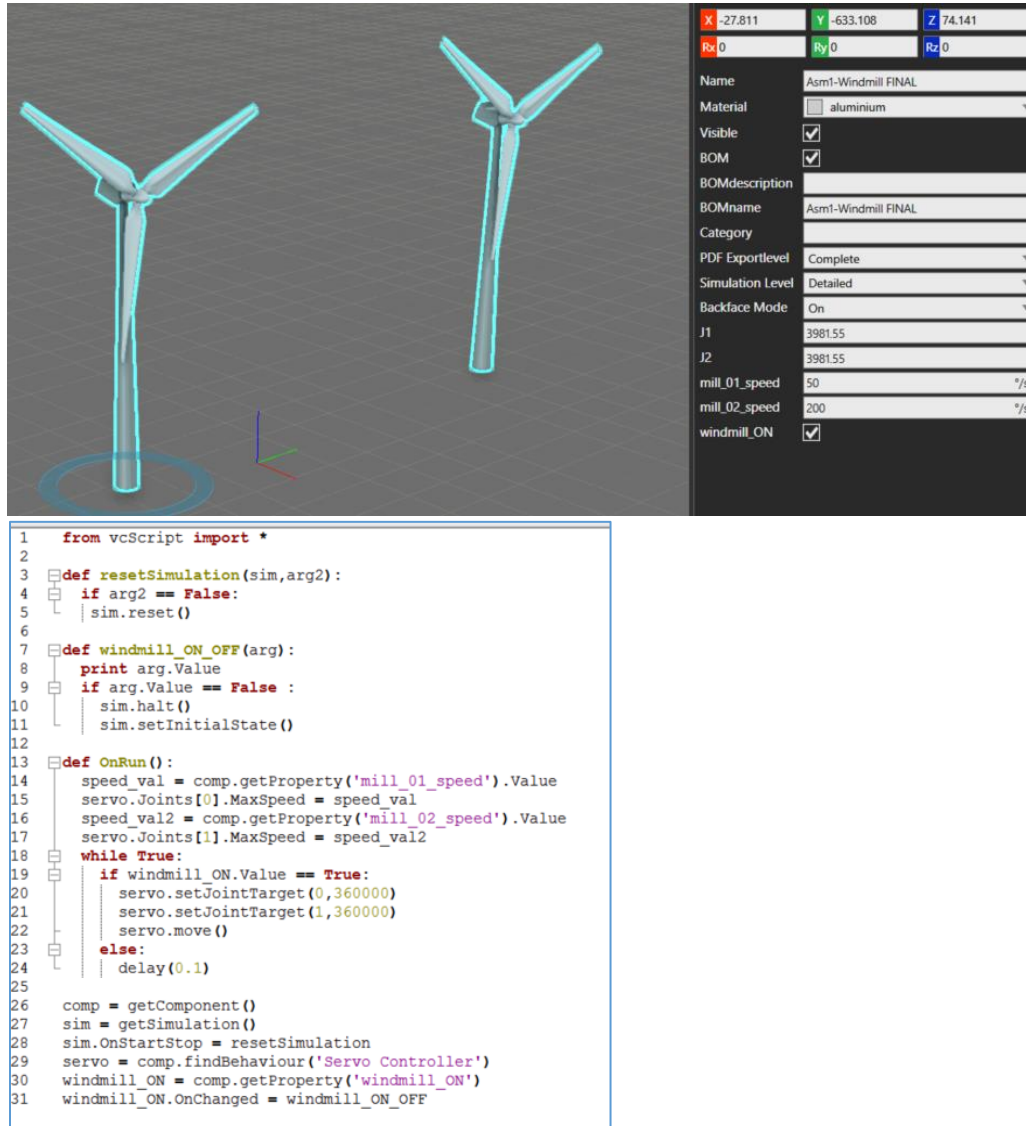
And then we need to connect the following variables in between Simulation side and Server side.

Structure	Simulation variable	...	Simulati...	Prepar...	Latest va...	..	Server variable	Server type
<div> <div> <div></div> <div></div> <div></div> </div> <div> <div></div> <div></div> <div></div> </div> </div>	<div> <div></div> <div></div> <div></div> </div>	<div> <div></div> <div></div> <div></div> </div>	<div> <div></div> <div></div> <div></div> </div>	<div> <div></div> <div></div> <div></div> </div>	<div> <div></div> <div></div> <div></div> </div>	<div> <div></div> <div></div> <div></div> </div>	<div> <div></div> <div></div> <div></div> </div>	<div> <div></div> <div></div> <div></div> </div>
Server								
Simulation to server								
Server to simulation								
Reservoir_Fluid_Level	Reservoir.Reservoir_Fluid_Level		66.62355041		66.62355041		Reservoir_Fluid_Level	Float
Tank_Fluid_Level	Tank.Tank_Fluid_Level		62.06177520		62.06177520		Tank_Fluid_Level	Float
Pump_Status	Pump.Pump_Status		TRUE		TRUE		Pump_Status	Boolean
Beacon_Status	AlarmBeacon.Beacon_Status		FALSE		FALSE		Beacon_Status	Boolean

Change the inputs from the PLC %IW64 and %IW66 and see the changes in the simulation in fluid level of the reservoir and tank. This is a very simple example where we have put only 2 analog signal inputs to PLC and 2 digital signal outputs from PLC. You can also try to connect some signals in [Simulation to Server] field, to send out a digital signal and see the change will be easier in the PLC simulation box I have shown above as it has 9 digital outputs but for showing the effect of an analog signal output from simulation to real physical device we need to have some analog device e.g. Servo motor etc.



There is another layout [Windmill_Layout.vcmx]. We can also simulate the windmill speed change with PLC analog signal input. The windmill simulation with PLC has a simple concept. The user will change the value of speed of windmill with PLC analog signal e.g. IW96 and the below python script in the component [Winmill] will change the speed of servo.



So the user can connect the signals %IW96 and %IW96 with the variables (mill_01_speed) & (mill_02_speed), as well as make the analog signal reading ladder program in PLC. Then after connecting the PLC via VC Premium (via KEpServerEx) he can run the simulation and observe the effect of speed change.

All the necessary - #layout #components #PLC program are attached with this instruction file. User needs to download KepServerEx 6.0 or higher from Kepware website.