

**VijeoCitect and W@DE RTU
DNP3 Solution**

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1 VijeoCitect / W@DE DNP Solution

1.1 Introduction

The purpose of this document is to give you a basic understanding of how to configure VijeoCitect and W@DE RTU(s) to communicate with one another via DNP3 over ethernet. There are many parameters (hundreds) available on both the VijeoCitect and the W@DE RTU side which allow you to adjust how the system functions. We will go over a few of them but it is best to consult the documentation for VijeoCitect DNP driver and the W@DE RTU configuration manuals for more details.

A bit about DNP and VijeoCitect read/writing polling:

DNP is a multi-layered protocol, with transactions occurring on multiple layers. This description is only concerned with protocol transactions handled directly by the VijeoCitect driver.

DNP allows the master (Vijeo Citect) to poll a unit for the current value of a group of pre-configured I/O points, via a single request. This is a Class0 poll (Class 0 has all of the master's relevant I/O points predefined), also termed as STATIC poll. Data reported as a current value is termed *static* data. DNP also allows the master to poll a unit for value changes in a group of pre-configured I/O points, via a single request. This is a Class1, Class2, or Class3 poll (these are all functionally equivalent, but the separate groups afford more flexibility in configuration). Data reported as a change in value (also known as an event), is termed *dynamic* data. An event may also include a timestamp field. DNP allows these different polls to be combined into one request. A poll for Class1, Class2 and Class3 is termed an event poll, as it will acquire all events that have been queued in the device and are awaiting transmission. A poll for Class0, Class1, Class2 and Class3 is termed an integrity poll, as it will acquire all events that have been queued in the device and are awaiting transmission, and then it will acquire a snapshot of all the current values.

The VijeoCitect driver allows each unit to have its polling period, and the ratio of integrity polls to event polls, defined. The driver also supports additional functionality such that an operator can generate on demand integrity and event polls.

DNP allows a unit to have the master's address be stored internally, so that the unit(W@DE RTU) is capable of transmitting unsolicited responses of event data to the master(VijeoCitect). An event may also include a timestamp field.

The VijeoCitect driver is capable of receiving and processing responses regardless of whether the response contains static or dynamic data, and regardless of whether the response is initiated by a master's request or initiated as an unsolicited response. All responses are used to update the driver's cache, and relevant time-stamped events are used to update configured time-stamped alarms and trends, via the DriverRuntimeInterface.dll .

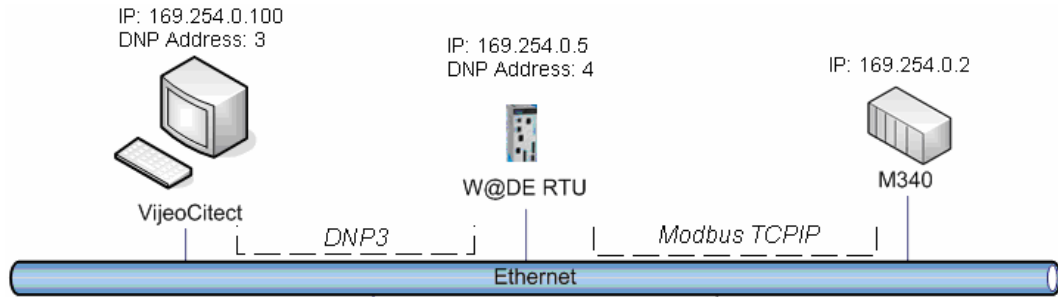
Write requests from VijeoCitect may result in a physical write to the device, or they may only write to cache (in the case of internal values, eg OnTime), or they may actually trigger the driver to perform a function (eg Reset Poll Counters).

Read requests from Citect are serviced through the driver's cache.

Note: at the time of this document VijeoCitect DNP3 driver 4.02.12.00001 BETA was used.

1.2 Solution Architecture Diagram

The architecture will have VijeoCitect talking DNP3 over Ethernet to a Schneider Electric W@DE RTU which in turn is talking Modbus over TCP/IP to an M340 (as the diagram below shows).



2 W@DE Configuration

2.1 Web browser

It is assumed you have configured your W@DE to utilize DNP3 and that it is on the network with the appropriate IP Address (our case: 169.254.0.5). You should be able to go to your web browser and bring up the login page for the W@DE configurator. You should login with admin privileges (default: username:adm pwd:adm).

Please consult the W@DE User Manual if you can not get to the W@DE Configurator web page.

2.2 Settings|Operation Mode Menu

Configuration should be as follows:

2.3 Settings|Protocol. + TCP/IPor.1)) Menu

2.3.1 DNP3 IP Parameters Configuration section

SCADA IP Address= IP address of the SCADA server

2.3.2 DNP3 Parameters Configuration

Port 3: SCADA Address is the DNP Address of VijeoCitect (3 in our case)

Device Address is the DNP Address of the W@DE (4 in our case)

DNP3 Parameters Configuration				
Port 3:	SCADA address	3	Device address	4
Port 4:	SCADA address	0	Device address	0

We are only utilizing Port 3:

2.3.3 Application Layer

This is where we actually can configure the W@DE to send unsolicited responses via a specific DNP Class. Here we are telling W@DE to only send unsolicited responses for DNP Class1 objects.

Application layer				
Port 3:	Sends unsolicited responses	Yes	Class1 <input checked="" type="checkbox"/> Class2 <input type="checkbox"/> Class3 <input type="checkbox"/>	
	Unsolicited wait delay	1000 ms	Objects Index	16 bits
	Maximum application re-tries	3	Application time-out	60000 ms
	Requires application confirm	No	Handle requested object unknown bit	Yes
	Select Timeout	5 s	Clock validity	3600 s
	Use of double-bit binary input	Yes	TM read mode	Standard

We are only utilizing Port 3.

2.4 Settings|Operation Mode Menu

Here is where we are telling the W@DE that we will communicate DNP3 over TCP/IP on the TCP/IP ports. Your configuration should be as follows:

Communication general parameters			
Communication parameters on physical ports			
Protocol :	DNP3		
Port 1 Mode:	No report by exception	Link: Normal	Media:
Port 2 Mode:	No report by exception	Link: Off	Media:
Communication parameters on TCP/IP ports			
Protocol :	DNP3 over TCP/IP		
		Link: Normal	
Save			

2.5 Settings|Modbus Master Communication Menu

2.5.1 Modbus TCP Client Parameters

Here we will configure the W@DE to use port 502 to communicate to the PLC. We can also setup different scan groups (Topics) on how often we want the W@DE to scan the PLC for data. In our example we will only configure Topic 1 at a 1sec scan rate. The Modbus Slave Address of the PLC is 2. When we create the variable object in the W@DE, we will assign the object to a Topic.

Your configuration should be as follows:

Modbus master Communication Configuration					
General Parameters					
Serial Line Interface:	RS485	Reply Timeout:	1000	ms	
	Polarization:	<input checked="" type="checkbox"/>			
Transmission speed:	19200	bauds	Parity:	Even	Number of stop bits
					1
maximum frame length:	255	Event Polling period:	1000	ms	
Address Gap Span:	0	No complementary filtered time:	1000	ms	
Events on validity change:	<input type="checkbox"/>				
Modbus TCP Client Parameters					
Server Port	502	Connection Timeout	60	s	
Topic					
1	Slave Address:	2	Watch period:	1000	ms Topic On: <input checked="" type="checkbox"/>
2	Slave Address:	1	Watch period:	2000	ms Topic On: <input checked="" type="checkbox"/>
3	Slave Address:	1	Watch period:	3000	ms Topic On: <input checked="" type="checkbox"/>
4	Slave Address:	1	Watch period:	4000	ms Topic On: <input checked="" type="checkbox"/>
5	Slave Address:	1	Watch period:	5000	ms Topic On: <input checked="" type="checkbox"/>

2.6 Settings|Slaves Configuration Menu

Define the IP Address of the M340 (Slave Device) and make sure it is 'Active'.


Slave:		Events:	Time Format:	Time Synchronisation:		IP Address:
Active	Type	Address	Address	Period		
1 OFF	other	1	Type CEI (4 words)	0	0	x10s 192.168.3.71
2 ON	other	2	Type CEI (4 words)	0	0	x10s 169.254.0.2

Save

2.7 Settings|Classes Configuration Menu

The Class here is not the DNP Class. This is just a means to organize your data for viewing within the W@DE web environment (Monitoring Menu).

Classes configuration		
<input type="checkbox"/>	Class name	Confirm
<input checked="" type="checkbox"/>	My Class Name Here	Save
<input type="checkbox"/>	Digital Inputs	Save
<input type="checkbox"/>	Internal Information	Save
<input type="checkbox"/>	M340	Save
<input type="checkbox"/>	Quantum	Save
<input checked="" type="checkbox"/>	CH2M Hill Test	Save
<input type="checkbox"/>	Austin	Save



Home

WADE

Administrator

Control Diagnostic Maintenance Settings

Monitoring

Classes

[- CH2M Hill Test](#)

Equipment status	
Label	Status
CH2M Hill Test	
Pump in Auto_100002	Manual
Pump Fail Status_100004	Normal
Pump Run Status_000040	Running
Pump Start Cmd_000050	Start
Pump Stop Cmd_000052	Off
Valve in Auto_400035.2	Manual
Valve Open Status_400035.4	InActive
Valve Close Status_400035.7	Inactive
Valve Open Cmd_400037.3	Inactive
Valve Close Cmd_400037.6	Inactive
Pump Start Setpoint_400020	6.00
Pump Stop Setpoint_400022	2.00
Valve Open Setpoint_400030	6.00
Valve Close Setpoint_400032	3.00
Flow_400005	2519

2.8 Settings|Variable Configuration Menu

Define a variable object. Depending on the variable type (DI/DO/AI/AO) you will have different configuration screens. In this document, we will define AI, AO, DI, and DO as these will be used in the VijeoCitect demonstration.

2.8.1 Adding a variable of type AI

- General Parameters:
 - § *Variable Name* – DNP Object Name
 - § *Class*: W@DE class as defined in section 2.7
 - § *External Address*: <DNP Address>, <DNP Class> - DNP Address is a unique number between 0-65565. DNP supervisor (VijeoCitect) will utilize this reference to access the object. DNP Class is optional. On our variable set it to be of DNP Class2. If you omit the DNP Class, it defaults to Class1.
- Modbus Master Communication Parameters
 - § *Topic*: Topic to which variable is attached - as defined in section 2.5.1
 - § *Type*: Configurable on analogs.
 - § *Slave Address*: To overwrite the Slave Address defined in Topic
 - § *Word*: Word address in the PLC of the analog information (example here is %MW4, the modbus address of the Variable (Flow_6 T005) is 6 T005 and the address entered here is based upon IEC 0: %MW4)
 - § *Read Function*: Modbus function to be used by the W@DE to read the data from PLC.

- Periodic Treatment
 - § *Log* : Period defines how often to log into Measures Log (Diagnostics|Measures Log menu) within W@DE RTU.
 - § *Event*: Activate saving of event to the DNP protocol event stack according to the Type and Period criteria (create event of sample type every 10 sec).
- Threshold Treatment
 - Log and Event same as Periodic Treatment only based on thresholds.
- Dead band
 - Log and Event same as Periodic Treatment only based on deadband
- Alarms Configuration
 - Alarm Level is the W@DE Alarm Level configured under the Settings|Alarms menu (not used in this demo)
- Min and Max Log
 - Period of the logs defined.

Adding a variable of type AO

Measurement configuration					
General Parameters					
Variable name	Valve Open Setpoint_400030			Precision	0,01
Logical Address:	A04	Class:	CH2M Hill Test	Access:	DISPLAY
Internal Address:	0			External Address:	106
Unit:		Scale:		Max value:	100
				Min value:	0
Modbus Master Communication parameters					
Topic	1	Type:	Real (L/H)	Read only:	<input type="checkbox"/>
Slave Address:	2	Word:	29	Bit:	0
				Length:	0
Read function:	03: Read Holding Registers			Write function:	16: Write Registers
Periodic treatment					
<input type="checkbox"/> Log				<input checked="" type="checkbox"/> Event	<input type="checkbox"/> Dial-Up
Period	15 min	Type	Average	Period	10 sec
Threshold treatment					
<input type="checkbox"/> Log				<input type="checkbox"/> Event	<input type="checkbox"/> Dial-Up
High threshold	<input type="checkbox"/> Value	0			
Low threshold	<input type="checkbox"/> Value	0			
Dead band					
<input type="checkbox"/> Log				<input type="checkbox"/> Event	<input type="checkbox"/> Dial-Up
Method	Fixed	Value	10		
Minimum variation	In				
configuration					
level :	1				
<input type="checkbox"/> Max log	<input type="checkbox"/> Maximum Active			<input type="checkbox"/> Minimum Active	
value	1 Day				
<input type="button" value="Save"/> <input type="button" value="Cancel"/> <input type="button" value="Delete"/>					

The same as AI with a few fields to explain:

- § *External Address:* When we just enter the DNP address with no DNP Class the object defaults to Class1
- § *Write Function:* Since this is an AO we can write to the object so we have to setup the write function.

2.8.2 Adding a variable of type DI

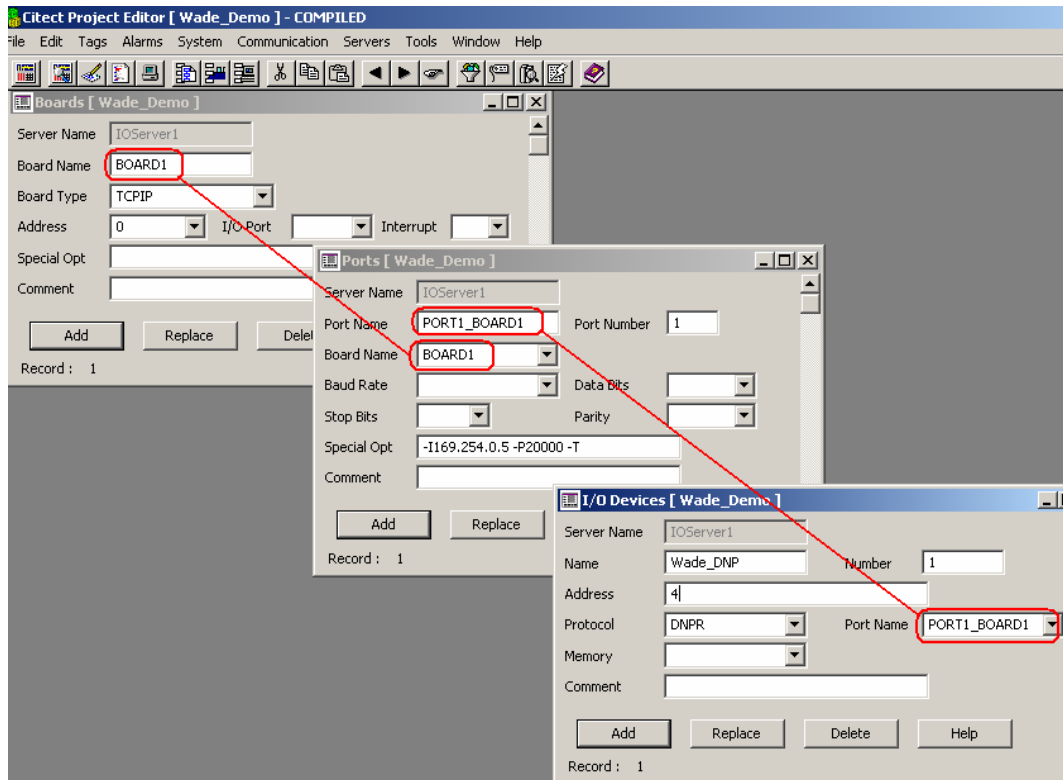
The same as AI with a few fields to explain:

- § *Active/Inactive Status*: This is how you want it displayed on the screen in the Monitor menu. In the example here we will display words (Open or Inactive) based on the bit being on or off. It will also have a background color of red for Open and Green for Inactive.
- § Note that for digital data any change of state on a variable automatically generates recording in the protocol event stack. For the other types of variables (AI, AO, etc) it is configurable.

2.8.3 Adding a variable of type DO

Same as DI configuration.

You should have the following configuration for Boards, Ports, and IODevices:



Note the following:

- § Port configuration is where the wizard places the IP address of the W@DE (-i<no space>IP Add) and also the TCP Port as configured in the W@DE's DNP3 IP Parameters Configuration (-P20000).
- § IODevice is the place where the Wizard places the DNP address of the W@DE (4).

Protocol Parameters DNP3			
DNP3 IP Parameters Configuration			
Port 3:	SCADA IP address	169.254.0.100	TCP Port 20000
	Connection Mode	Server	Outgoing TCP Port 20000
	Dest UDP Pprt	20000	Init UDP Pprt 20000
	Local UDP Port	20000	UDP Mode Configured value
	Timeout	60 s	
Port 4:	SCADA IP address	0.0.0.0	TCP Port 20000
	Connection Mode	Server	Outgoing TCP Port 20000
	Dest UDP Port	20000	Init UDP Port 20000
	Local UDP Port	20000	UDP Mode Configured value
	Timeout	60 s	
DNP3 Parameters Configuration			
Port 3:	SCADA address	3	Device address 4
Port 4:	SCADA address	0	Device address 0

- § -T option on the Ports form tells the driver to use TCP and not UDP (-U option).

Step 3: VijeoCitect INI File Settings

You will want to set the following DNPR parameters in the Citect.ini file (thru the Computer Setup Editor). For more details on the available parameters and their descriptions please see the DNPR documentation for VijeoCitect (there are many parameters).

[DNPR]

SCADAAddress=3 ! The DNP Address Matches W@DE configuration for the SCADA in DNP3 Parameters

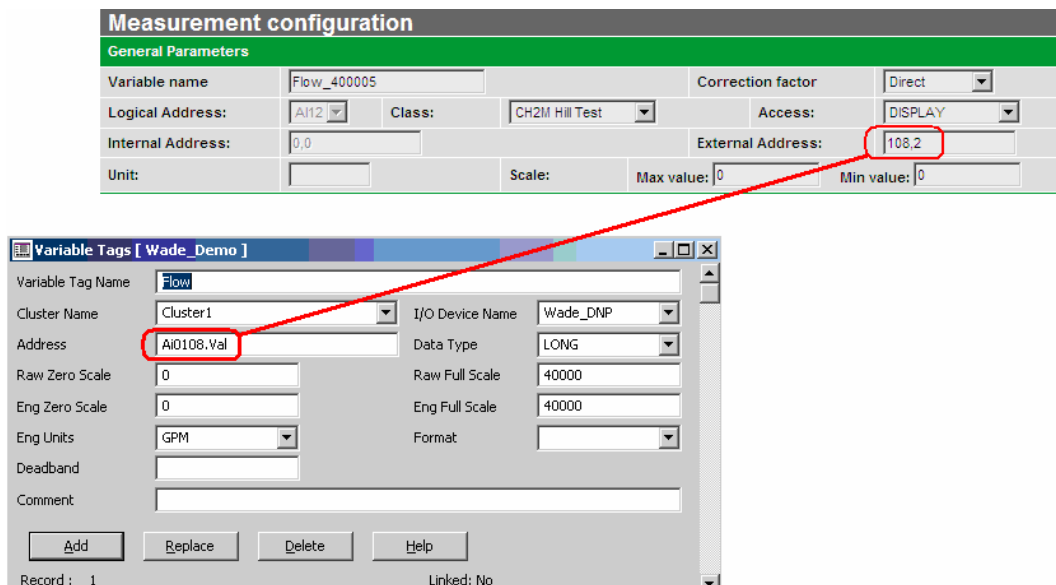
EventPollPeriodDefault=30 !Event Polls occur every 30 sec

EventPollRatioDefault=2 !After every 2 Event Polls on the next poll do Integrity Poll – ePoll, ePoll, iPoll,ePoll...

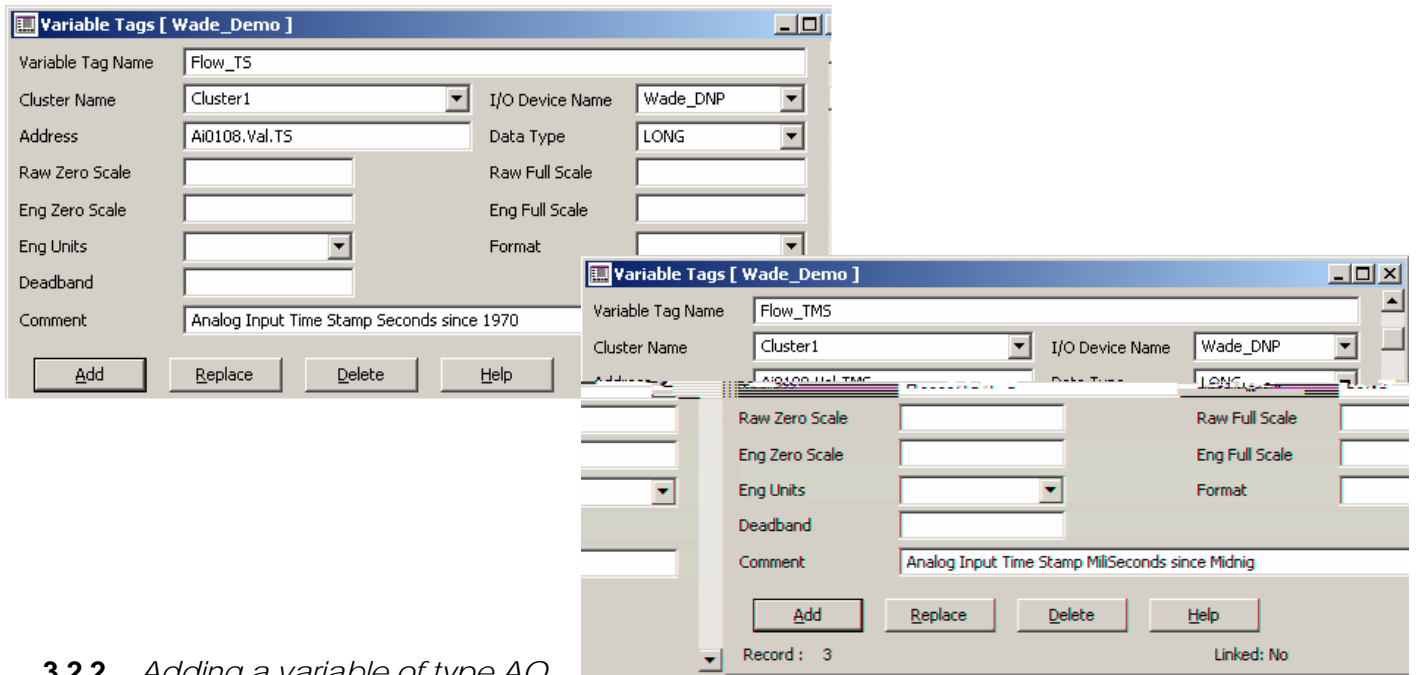
ProcessTrendEvents=1 !Turn on if you want event trends process by the driver otherwise only alarm events on

3.2.1 Adding a variable of type AI

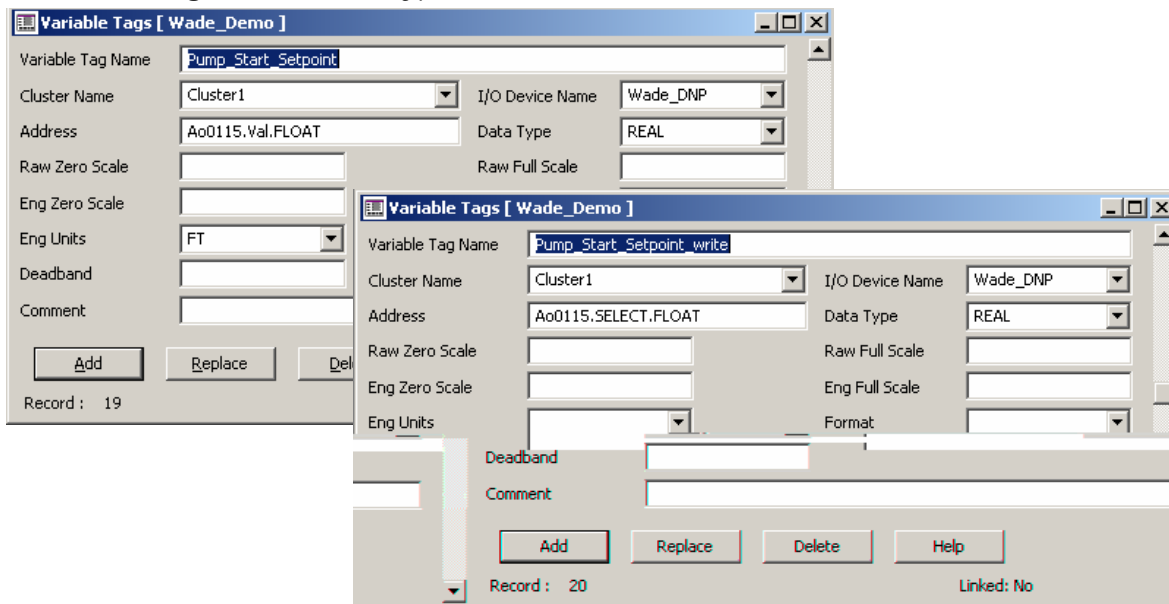
Configure a variable tag called *Flow* with an Address of AI0108.Val (108 is the DNP address defined in the W@DE configuration. Set the Eng and Raw scales as shown below (since this is the LONG and we will want to trend it – remember if no scaling defined it defaults 1-32000 so need to specify limits.)



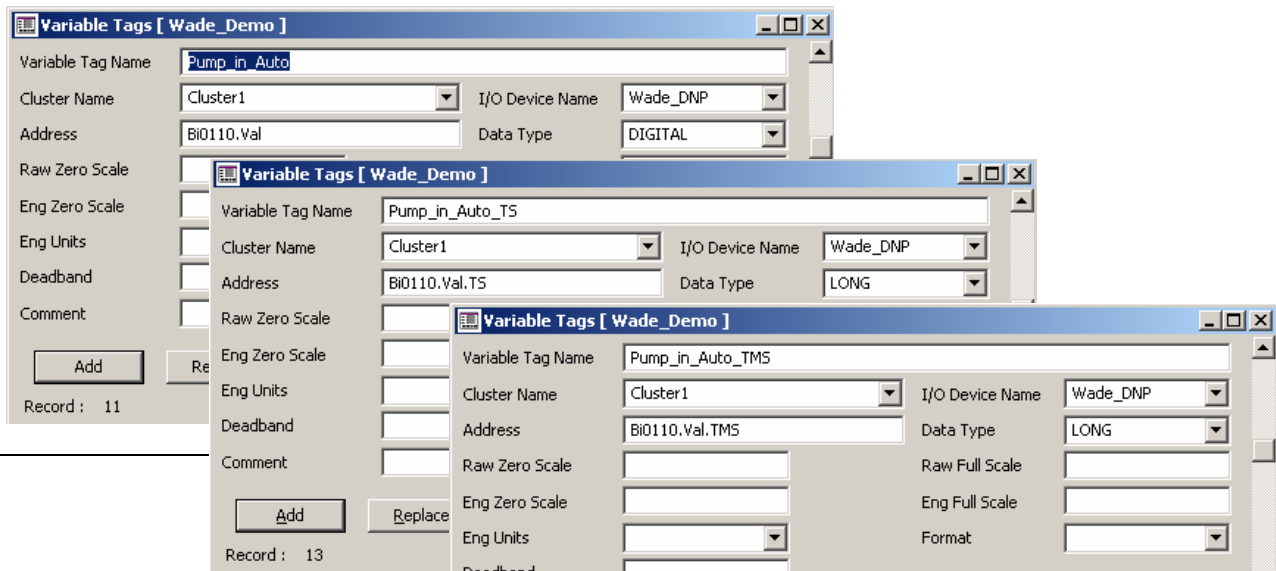
Because we want to display the timestamps on the screen, we want to create VijeoCitect tags that will hold the timestamps. The timestamp is coming from the W@DE and is embedded in the DNP message to VijeoCitect on each object read/event. To get to it, we will define 2 tags (a .TS – time seconds and a .TMS – time millisecond). The VijeoCitect driver will automatically grab the time stamps from the DNP protocol message and place them within the defined variable tags. You will see how we utilize these tags later when we display them on the screen.



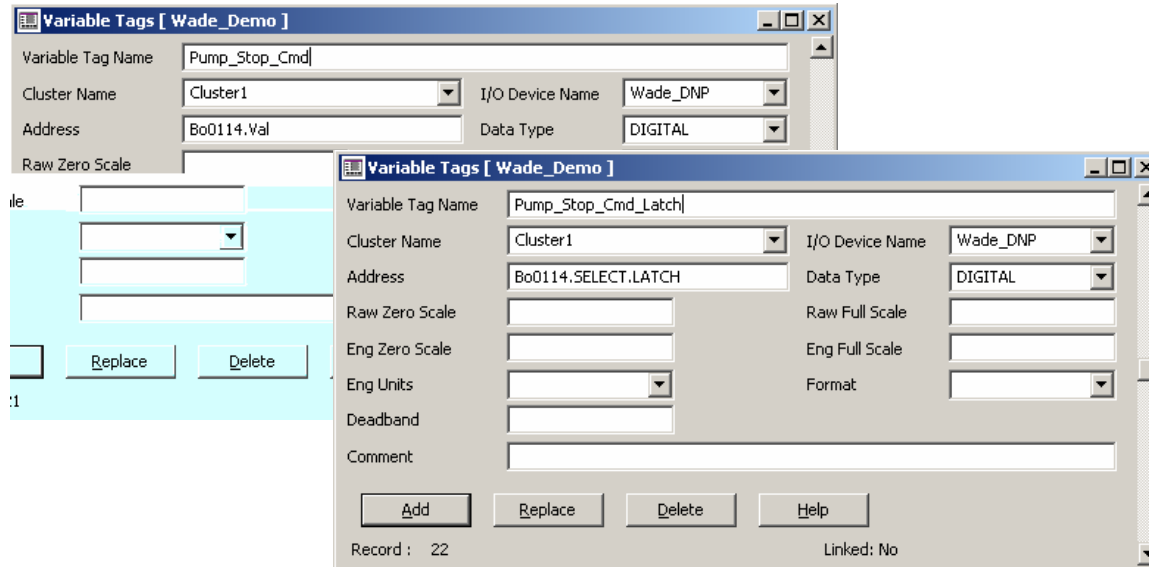
3.2.2 Adding a variable of type AO



3.2.3 Adding a variable of type BI



3.2.4 Adding a variable of type BO



3.2.5 Add Alarm Configuration

Step 1: Create the Category so that we can see the millisecond information (timestamp from RTU) on the alarm page in runtime.

Alarm Categories [Wade Demo]

Category Number 1 Priority 1

Display on Alarm Page TRUE Display on Summary Page TRUE

Unacknowledged Acknowledged

Alarm Off Font Alarm On Font Alarm Disabled Font

Action Action Action

Alarm Format: {DATE,10}^t {TIME,14}^t {Millisec,3}^t {TAG,8}^t {NAME,8}^t {DESC,8}^t

Summary Format: {TAG,10}^t {NAME,12}^t {SUMDESC,10}^t {ONTIME,12}^t {OnMilli,3}^t

Primary Device Log Alarm Transitions

Device ON OFF ACK

Comment

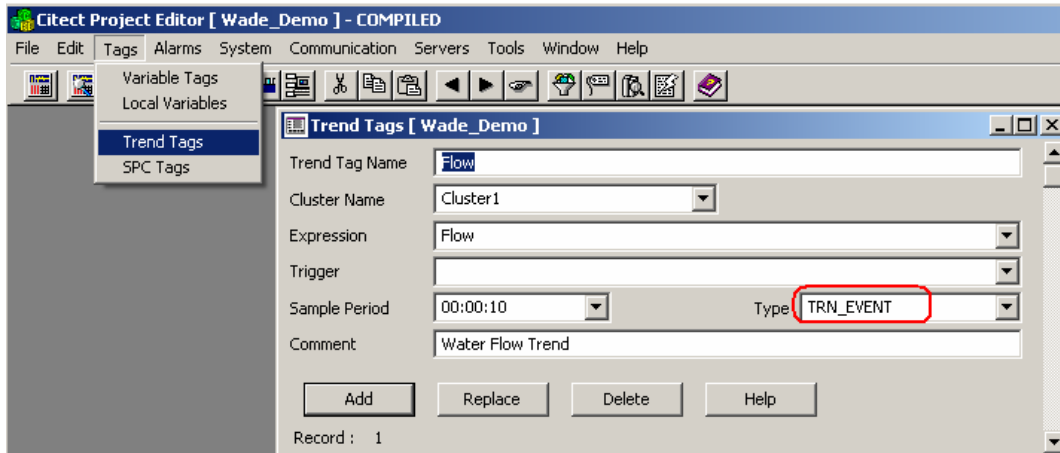
Add Replace Delete Help

Record : 1

Step 2: Create a Time Stamped Digital Alarm and Time Stamped Analog Alarm (as shown).
Assigamped 3c

3.2.6 Trend Configuration

Configure an Event Trend (only event trends are supported for pushing data and timestamps in from the RTU).

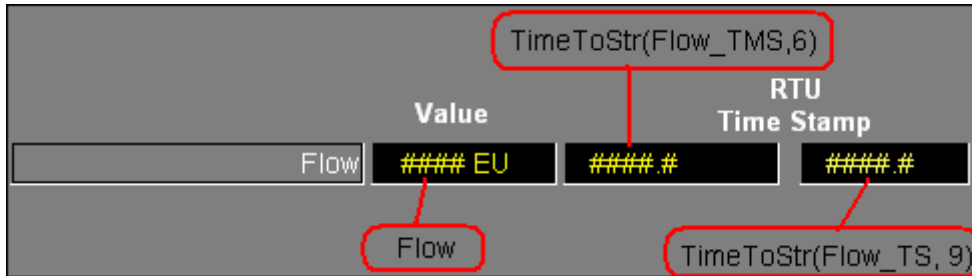


3.3 Graphics Page Configuration

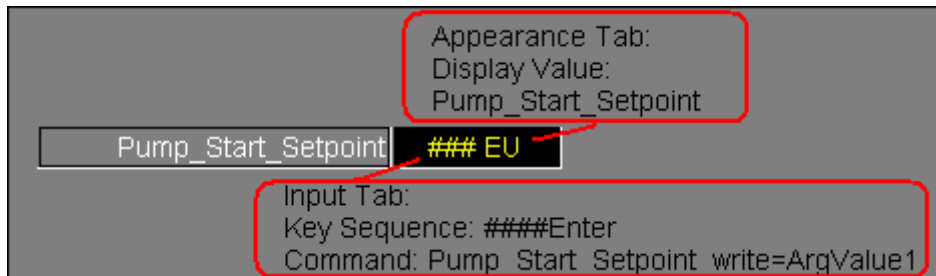
The easiest thing to do is utilize the WADE_Demo project created for distribution with this document.

If you don't have a copy of the project you can create a display with the following examples

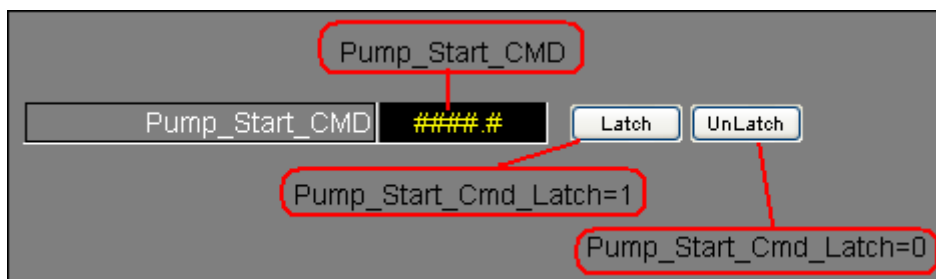
For an AI (and BI) tag type such as Flow (ReadOnly):



For an AO tag type such as Pump_Start_Setpoint:



For an BO tag type such as Pump_Start_CMD:



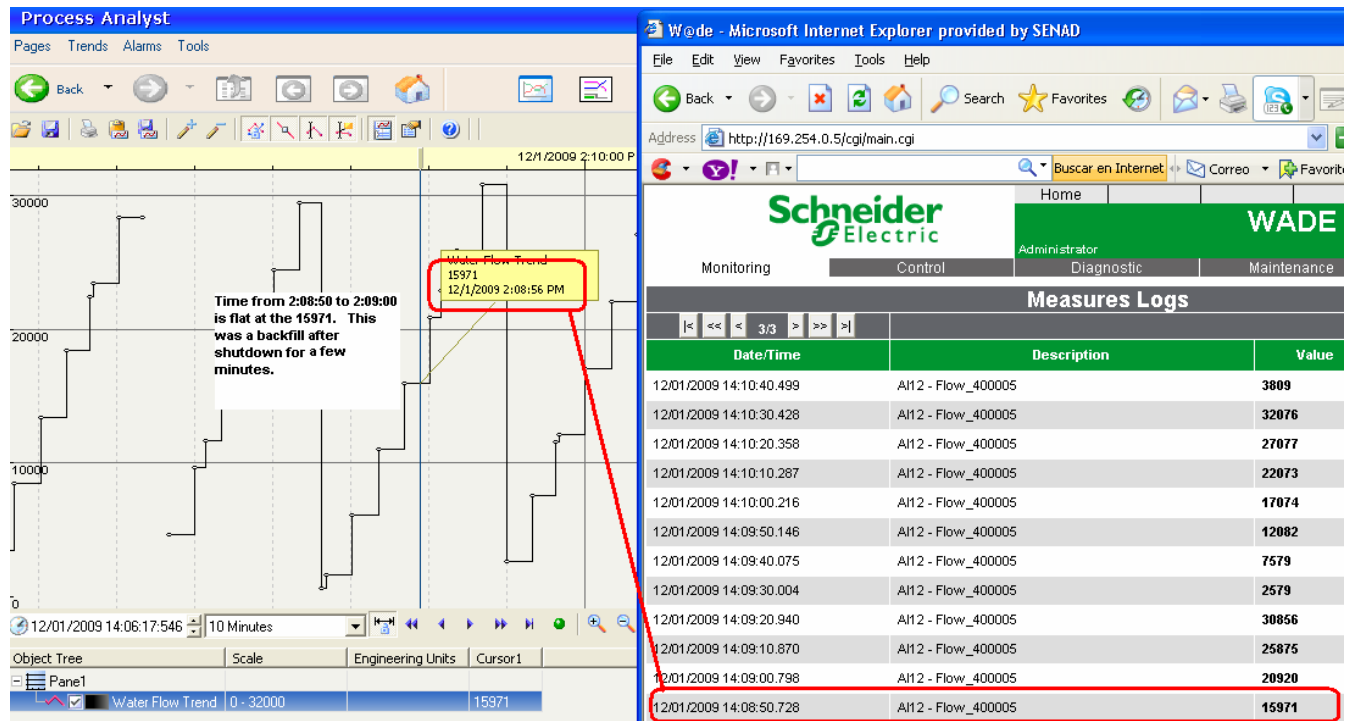
5 Trend Demonstration

Step 1: Go into runtime and confirm comms

Step 2: Go to Process Analyst and add a Trend Pen.

Step 3: Right mouse click and right mouse click. Go to Properties. On the Main Page tab under Process Analyst View|Pane1 select <your trend name>. On the Appearance Tab to the right select Interpolation: Stepped.

Step 4: Open the W@DE Diagnostic Measures Log side by side with Process Analyst. You should see the trend values match.



Step 5: Disconnect the Ethernet cable from the SCADA PC (to simulate a lost of communication) and wait a specified time period. Observe the display that was built in Section 3.3 and notice the data has gone to #COM indicating the lost of real time data. On the W@DE web interface go to the W@DE Measures log and observe samples being logged (remember in the W@DE config we said log every 10 sec). The W@DE will have put an event on the Protocol Event Stack every 10 sec as we have configured.

Step 6: Observe 4-5 samples enter the log and then reconnect the VijeoCitect network connection. Upon reconnection of comms between VijeoCitect and the W@DE, VijeoCitect will go and read from the Protocol Event Stack (which contains the events in the W@DE) bringing in the 'missed' trend data and inserting it into the SCADA trend system. Next go to the Process Analyst, and when VijeoCitect finishes obtaining all the event data you will see the trend data fill in appropriately (this may take a minute to process the events). Check the data with that which is logged in the Measures Log (as shown above). This proves that VijeoCitect has gone out to the W@DE, pulled the Events off the Protocol Event Stack, and insert the data into the SCADA trend system. All this is done automatically by the VijeoCitect driver.