

BECKHOFF DNP3 Master/Slave Driver User Manual

V3 RC24

27 August 2022



www.pbsControl.com

1	Kamjoo bayat	Create Ver 1.0 document	Q1 - 2014
2	Kamjoo Bayat	Adding SYS , WDT Tags to kernel and make it non block operation Ver 1.3	Q4 - 2014
3	Kamjoo bayat	Adding Multi Master	May - 2015

		Functionality to driver , adding driver boot delay	
4	Kamjoo Bayat	Adding RTU Restart when No communication between TC and DNP Kernel	August 2016
5	Kamjoo Bayat	Adding Some notes about TC Routers setting in Manual	March 2017
6	Kamjoo Bayat	Adding DNP3 Master Functionality Release of V3 RC5	Jan 2019
7	Kamjoo Bayat	Adding Data logging based on SQLite database – Adding Time Label and Flag to Signals , increasing number of DNP slave to 7 instance , RC15	March 2019
8	Kamjoo Bayat	Adding DNP Tag Status to DNP3 Slave Driver , DNP Master Enhancement , Fixing ADS Lost Connection with Reconnecting to ADS Server	August 2019
9	Kamjoo Bayat	Adding Direct DNP Tag Mapping from Master to Slave Kernels	Sep 2019
10	Kamjoo Bayat	Adding mse event gathering from ADS	Oct 2019
11	Kamjoo Bayat	Multi drop RS485 master driver mode is included	Nov 2019
12	Kamjoo Bayat	Adding Multifragment to APP Layer	FEB2020
13	Kamjoo Bayat	Fixing Time Label Bug in DIE	DEC 2020
14	Kamjoo Bayat	Develop new FB for DIE Transfer	1 Jan 2021
15	Kamjoo Bayat	Adding KepwareEX Connection to Manual	24 April 2021

16	Kamjoo Bayat	Fixing problem regarding UTC Time	27 August 2022
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1 – Introduction

pbsControl company developed DNP3 Master/Slave driver for BECKHOFF CX Series Controllers . DNP3 Driver is compatible with WinCE5.0, WinCE6.0 and Win32 .Please refer to www.beckhoff.com for detail information about CX Series Controllers.

DNP3 Driver is developed by C Language and gets small resources of Controller. So it is running smoothly on CX8000 and CX9000 controllers.

For technical support please contact kb@pbscontrol.com

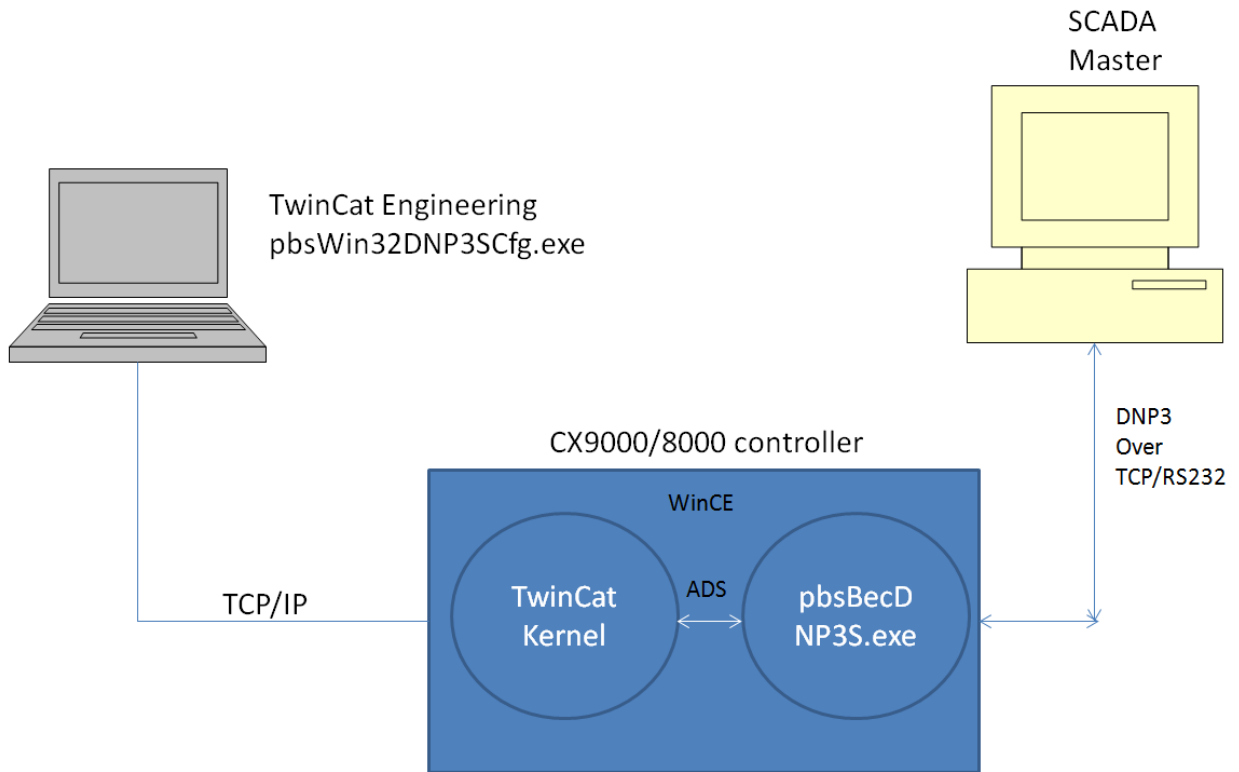
Driver license is linked to MACID of controller. Driver is running for 30 min without license as demo purpose. For each Controller you need to purchase separate license. License files for Slave and Master are separate.

Driver is tested with TwinCat 2 and TwinCat 3 .

2 – Driver Structure and installation

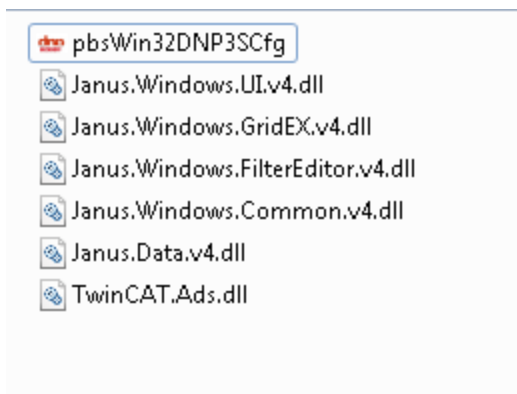
DNP3 Driver has following components:

- Configurator utility which is running on windows operating system. Configurator is developed by DotNet4. So you need to have DotNet 4 runtime engine on Configuration PC. (pbsWin32DNP3SCfg.exe)
- DNP3 Runtime kernel is running on CX9000/CX8000/CX1000 Controllers. (pbsBecDNP3SV3.exe) .Runtime kernel is developed by C for WindowsCE/win32 operating system and should run in CX Controller. Runtime Kernel is communicating with Twincat Kernel With ADS protocol for reading/Writing TwinCat variables and from the other side is communicating with DNP3 Master/Slave Driver.



Download DNP3 Slave Configurator utility from www.pbscontrol.com and unzip it at any path in configuration PC.

You can see following files:

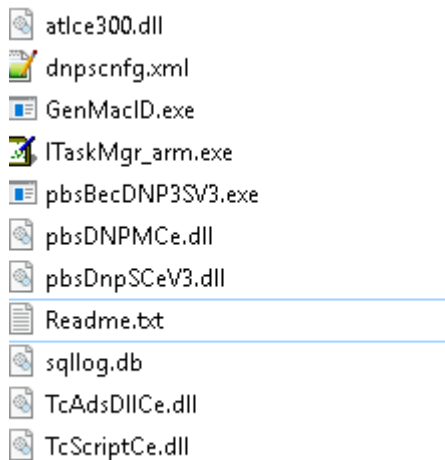


- pbsWin32DNP3SCfg.exe main utility for DNP3 slave Configuration.
- JanusXXXX user interface library (MUST be here)

- TwinCat.Ads.dll TwinCat Library for reading tags from CX Controller (MUST be here)

Download and unzip runtime kernel for CX9000/8000/1000/Win32 from www.pbscontrol.com

Make a new directory at CX controller and copy runtime kernel to this directory.



Put pbsBecDNP3sV3.exe at WinCE Startup. Search “Automatic Start of CE Applications” in Beckhoff Information system.

For win32 runtime kernel put pbsBecDNP3SWin32V3.exe kernel at windows auto startup folder.

For proper running of kernel you should have following files at root of driver folder :

- pbsBecDnp3sV3.exe main application
- pbsDnpMce.dll DNP3 Master library
- pbsDnpSCeV3.dll DNP3 Slave Library
- sqllog.db SQLite data base for logging DNP3 Master driver Tags
- dnpscfnfg.xml configuration file .

other folders are made automatically based on your configuration on the RTU by pbsBecDnp3sv3.exe application .

Run “Beckhoff CX Configuration Tool“ inside controller and do following settings at FTP tab:

Server Active: checked

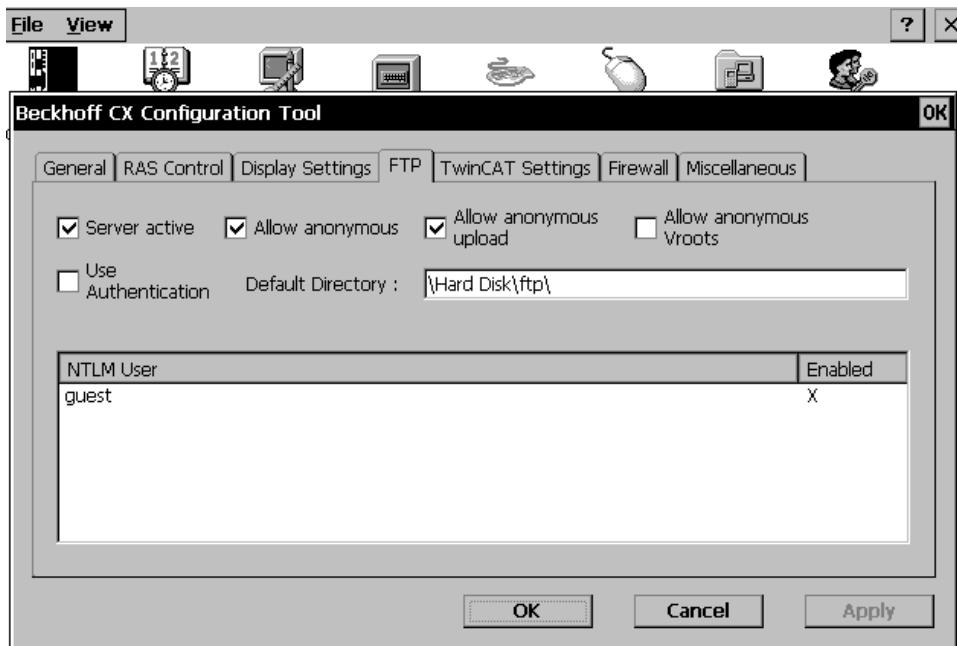
Allow anonymous: checked

Allow anonymous upload: checked

Use Authentication: Uncheck

Default Directory: Set to DNP3 slave runtime kernel directory

Restart controller. Now you are ready for DNP3 configuration.



We are using FTP for transferring Configuration and license file to controller. If you transfer configuration and license files by simple copy /Paste, it will work.

Dnpsi1 : first instance of DNP3 slave driver .

Dnpsi2 : second instance of DNP3 slave driver .

Dnpsi7 : seventh instance of DNP3 slave driver .

You can configure maximum 7 dnps slave instance on CX controller for communication with 7 DNP3 Master Software at the same time.

Dnpscfg.xml is configuration file which is making by configurator utility.if you want to copy /paste configuration file manually , you need to change name of your configuration (which is made by pbsWin32DNP3SCfg.exe) to dnpscfg.xml

License.lic driver license file which is linked to mac ID of controller. Without license file, driver will work for 30 Min for test and demonstration.

Licensem.lic license file for DNP3 Master Driver .

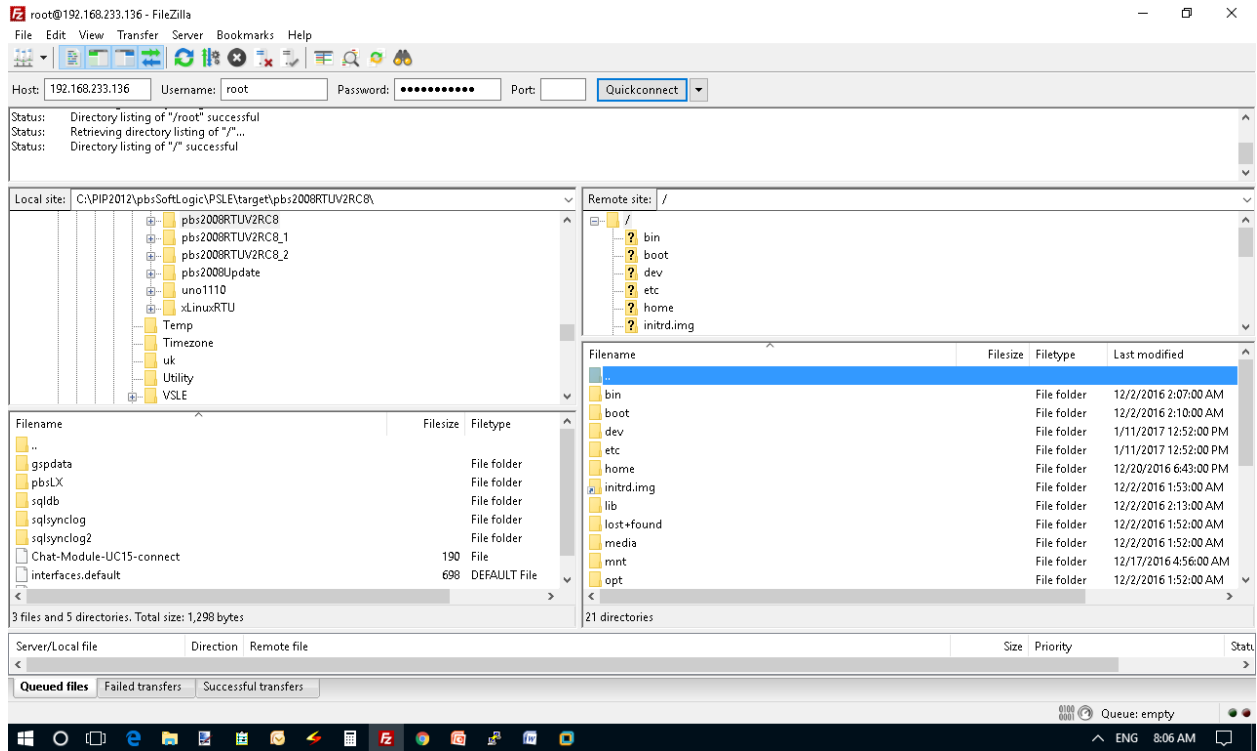
You can easily transfer files and Edit files by Filezilla client and Notepad++ utility. Please download and install them on Eng PC.

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 :



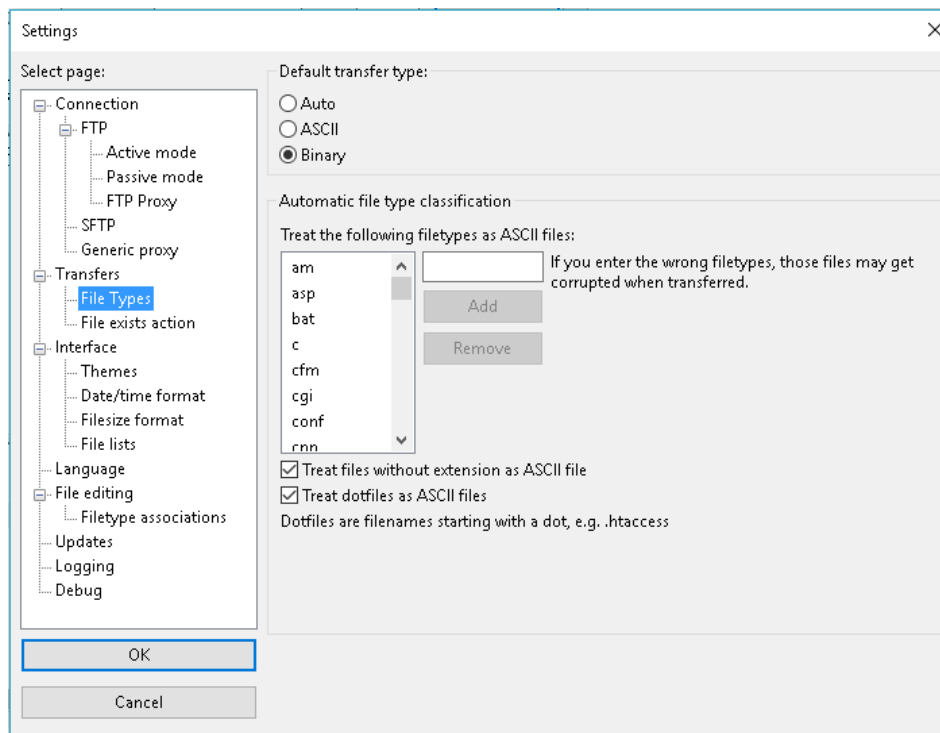
Type RTU IP at host field. Type root and root password in user name and password fields .for bechhoff RTU put user name and password blank and just click on quickconnect button .

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

By default Filezilla is showing CX FTP folder that is set before to DNP kernel folder at right panel .

Filename	Filesize	Filetype
..		
dnpsi1		File folder
dnpscfcg.xml	21,411	XML File
pbsBecDNP3SV3.exe	39,936	Application
pbsDNPMCe.dll	621,568	Application ext...
pbsDnpSCeV3.dll	181,248	Application ext...
Readme.txt	316	TXT File
sqllog.db	17,408	Data Base File

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



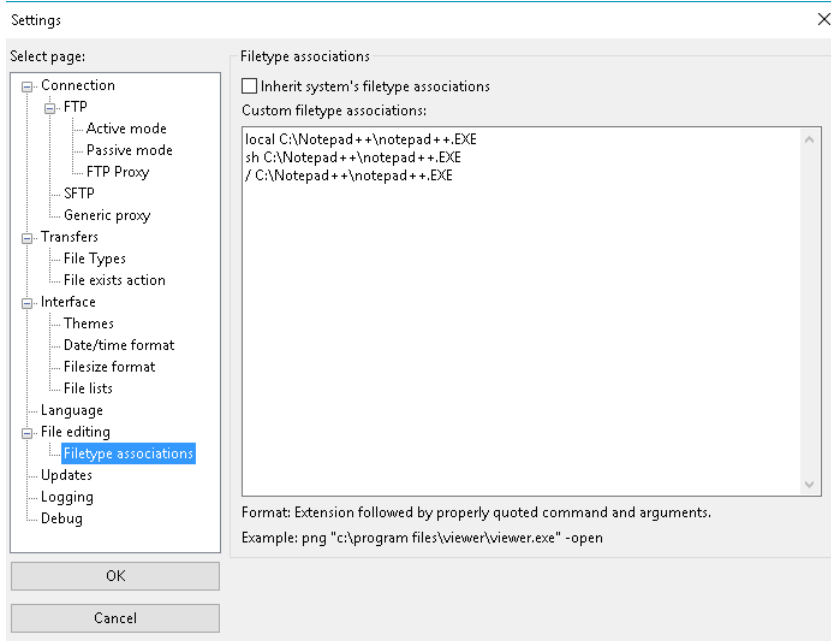
By default it is set to “Auto” that is damaging Linux files at transfer time from Windows to RTU.

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 :



3- Driver Configuration (Slave)

Run pbsWin32DNP3Scfg.exe utility. You will see following page:



Set CX controller IP address and AMS netID for communication with CX Controller. IP address is using for transferring configuration file to controller by FTP and AMS netID is used for reading twinCat Tags from controller.

TC PLC Port number : TwinCat Port number for communication. For TC Version 2 , use 801 and for TwinCat Version 3 use 851 .

Master Enable :for Enabling DNP3 Master Driver . If DNP3 Master is Enable you need to have License file for Master Driver . “Licensem.lic” otherwise kernel will stop after 30 Min

Use UTC :Time zone of DNP3 Master and CX controller should be same or both using UTC . Otherwise you will not get events and only class0 tags (current value of tags without time label) will move to DNP3 Master .

Start Kernel with Delay(Sec) : When Driver is starting , it will wait for this time (normally considered for proper loading of TwinCat Kernel) before connect to TwinCat Kernel .


TC Write Change Signals every msec to DNP3 Kernel : This parameter shows TwinCat time resolution for writing changes to DNP3 Kernel .

Master RS485 Gateway Mode: RS485 Gateway Mode is used for multi drop RS485 master driver. Please refer to DNP Master configuration for detail information.

DNP Slave Configuration:

You can connect CX RTU to 7 master SCADA at the same time. For each Instance you can set following parameters. First Instance (Slave1) is always enabling. But you can

Enable/Disable other instances. Select DNP Slave Tab. you will see following page:

 DNP3 Master/Slave configurator for Beckhoff CX controller Ver 3.0.0 RC23

File

Controller **DNP Slave** DNP Master About

Slave1 Slave2 Slave3 Slave4 Slave5 Slave6 Slave7 Digital Variations Analog Variations Tags

Physical Layer	Diagnostic
TCP ▾	Disable ▾
Serial Port	1
Baudrate	19200
TCP Port	20000
Master Address	1
CX Slave Address	3
Master IP Address	
Max Application Frame size	1024
SBO Timeout(Sec)	5
Link Status (Sec)	0 0 = Disable
Close-Trip Mode	CloseTrip in Differnet Address ▾
Class 0 Qualifire	0x28 ▾

Select physical layer TCP or RS232. You can select TCP or RS232 for each instance.

Serial Port: Port Number for communication in RS232 Mode .No affect in TCP Mode.

Baudrate : communication Baud Rate for RS232 Mode.

TCP Port : TCP Communication port number for TCP Port. By Default DNP3 port number is 20000.you should set different TCP Port number for each DNP Slave driver .

Master Address: DNP3 master SCADA address .Ask from master SCADA Administrator.

CX Slave address: DNP3 slave Address for CX Controller.

Master IP Address: DNP3 master SCADA IP address . If set to blank any IP can be connect to RTU .

Maximum application Frame size: Based on DNP3 protocol, maximum application frame size is 2048 bytes, but some masters could not handle 2048 bytes. Ask Master SCADA administrator for this parameter. We advise to use fewer values than maximum application frame size for this parameter. For example if Master supports 1024 bytes as maximum application frame size, set 1000 for this parameter. From version 3.RC23 Multi fragment application layer is supported and by default DNP Slave driver can transfer up to 2048 DNP Tags

SBO timeout (Sec): select before Operation time out for AOB and DOB tags.

Link Status (sec): This parameter is used in TCP /RS232 Mode. If master is not sending any request to RTU before No Communication timeout, then DNP3 driver will close connection and wait for a new master SCADA Connection. Link Status is linked to keep alive timer in master SCADA. Suppose Keep alive timer is 60 sec in master SCADA, then Master SCADA will send Link status command to RTU every 60 sec .In DNP3 slave driver you should set Link Status more than keep alive timer .For above sample you can set 80 sec.

If Link Status is set to 0, Link Status functionality is disabling and DNP3 Driver is not checking master communication request timeout.

Diagnostic : If you want to see DNP Frame on Beckhoff Screen for diagnostic purpose , you can use this parameter . you can see physical layer , Data Link Layer , Transport Layer and application layer messages by this parameter . Set this Parameter to disable in normal operation of RTU.

Close –Trip Mode : When DNP Master Send Trip or close command to RTU , for protection purpose , you can consider separate Digital Output Commands for Close and Trip operation . When you use different address for close –trip commands , then DNP slave driver is only accept Close command on even DNP Address and Trip on Odd DNP Address .

At Close-Trip in Same Address Mode , DNP Slave driver is not checking Even or Odd for DNP Address . So Master can send Trip and close command on Same DNP3 Address .

Class0 Qualifier: You can Set DNP3 Qualifier for answering to class0 by this option. This is used only for class0 reading .

Qualifier 0x00 : one byte is used for start address , one byte is used for end address and after that Group Data with variation without address is transferred . For example suppose RTU wants to transfer 10 DI from address 100 to 110 by Q 0x00 , then data will transfer as following :

1-2-100 – 110- DI Value 100 - DIValue110

In this mode , there is no any address with Data Points .

For Q 0x00 because one byte is considered for point address , so you can only transfer tags with dnp address less than 255 .

Qualifier 0x01 :Two bytes is used for start address , two bytes is used for end address and after that Group Data with variation without address is transferred . For example suppose RTU wants to transfer 10 DI from address 100 to 110 by Q 0x01 , then data will transfer as following :

1 -2-100-0–110-0-DI Value 100 - DIValue110

In this mode , there is no any address with Data Points .

For Q 0x01 because two bytes is considered for point address , so you can transfer tags address up to DNP Standard (65535)

Qualifier 0x17 : one byte is used for Number of Tags , and each data point has one byte for DNP Address . For example suppose RTU wants to transfer 10 DI from address 100 to 110 by Q 0x17 , then data will transfer as following :

1-2-10-100- DI Value 100 -101- DI Value 101- -110- DI Value 110

Qualifier 0x28 : two bytes is used for Number of Tags , and each data point has two bytes for DNP Address . For example suppose RTU wants to transfer 10 DI from address 100 to 110 by Q 0x28 , then data will transfer as following :

1-2-10-0-100-0- DI Value 100 -101-0- DI Value 101- -110-0- DI Value 110

Note : if your DNP address are in different range it is better to use Q 0x17 or 0x28 .

If you have different address range for Tags and you must use Q 0x00 or 0x01 then DNP Slave driver is automatically detected tags with same address range and make grouping based on tags address range .

For events only Q 0x28 is used for transferring events and unsolicited communication .

Basic DNP3 Concepts

Before describing Other DNP3 Slave parameters we need to review some DNP Concepts:

In DNP3 main data types are Digital(Binary) Input, Analog Input, Double Bit Binary Input, Counter, Frozen Counter, Digital(Binary) Outputs Status, Analog Output Status, Digital Output Command and Analog Output Command.

Any DNP3 Tag has current value (Class0) and buffered value (Class 1 , 2, 3) . Based on DNP3 Standard there is no priority for different class 1 , 2 and 3 .

When a DNP3 tag has class0 , it means tag value changes will not buffer with proper time label .

When DNP3 tag has class 1 , 2 or 3 , it mean tag value changes will buffer inside RTU with proper time of change .

In DNP3 for separating Static value of tags and event value (Buffered Data), Tag Group concepts will use.

The most common Groups are as following:

Group 1 is Static value of Digital Input Tag

Group 2 is event buffer of Digital Input Tag

Notice that these two groups refer to same DI tag. Group 1 shows current value and Group 2 shows event buffered.

Group 3 is Double Bit Binary Input Current value

Group 4 is Event Buffer of Double Bit Binary Input.

Double Bit Binary Input from DNP3 Document:

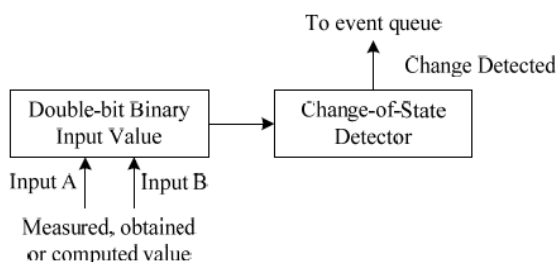


Figure 11-8—Double-bit binary input model

A double-bit binary input point is modeled as two single-bit binary inputs that are indivisibly linked together.

The four input states are defined in Table 11-14.

Table 11-14—Double-bit binary input states

State value (UINT2)	State name	Description	Corresponding state if a single-bit binary input were used instead
0	INTERMEDIATE	Transitioning between end conditions	—
1	DETERMINED_OFF	End condition, determined to be OFF	0
2	DETERMINED_ON	End condition, determined to be ON	1
3	INDETERMINATE	Abnormal or custom condition	—

Group 10 is Digital Output Status current value.

Group 11 is Digital Output Event Buffer.

Group 12 is Digital Output Command.

Group 20 is Counter static value.

Group 21 is Frozen Counter Static Value.

Group 22: event buffered of Counters

Group 23: Event buffered of Frozen Counters.

Group 30 is Static value of Analog Input

Group 32 is Event Buffer of Analog Input

Group 40 is Static value of Analog Outputs Status

Group 41 is Analog Output Command.

Group 42 Event Buffer of Analog Output

Group 50 is Data Time.

Group 80 is Internal Indication.

Internal Indication Concept: at any DNP3 Frame from Slave to master direction, There are 2 Bytes called Internal indication. (IIN) IIN is not in frames from Master to slave direction.

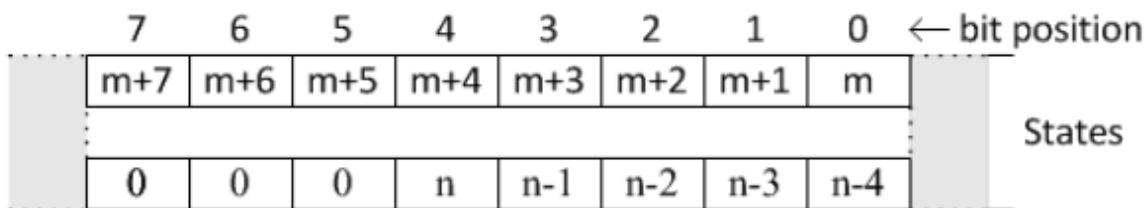
IIN definition is as following:

Index	Bit	Name
0	IIN1.0	BROADCAST
1	IIN1.1	CLASS_1_EVENTS
2	IIN1.2	CLASS_2_EVENTS
3	IIN1.3	CLASS_3_EVENTS
4	IIN1.4	NEED_TIME
5	IIN1.5	LOCAL_CONTROL
6	IIN1.6	DEVICE_TROUBLE
7	IIN1.7	DEVICE_RESTART
8	IIN2.0	NO_FUNC_CODE_SUPPORT
9	IIN2.1	OBJECT_UNKNOWN
10	IIN2.2	PARAMETER_ERROR
11	IIN2.3	EVENT_BUFFER_OVERFLOW
12	IIN2.4	ALREADY_EXECUTING
13	IIN2.5	CONFIG_CORRUPT
14	IIN2.6	RESERVED_1
15	IIN2.7	RESERVED_2

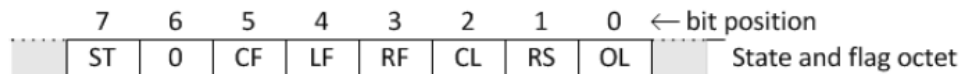
Tag Variation : in DNP3 Master can read data from RTU by different presentations . Suppose in first read ,master wants to read analog Input from address 1 to 100 by 32bit format and in second scan master read same analog input in 16 bit format . So Variations are refer to same tag Group.

Each Group has different variations.

Group 1, Static value of Digital Input, Variation is packed format.



Variation 2 is with flag:



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.

What is concept of Default variation?

Suppose master wants to read all tags in class 1.in this query master is not determine variation for Slave. Only master is asking for class1 tags. For this type of Master request, default variation should be set in RTU.

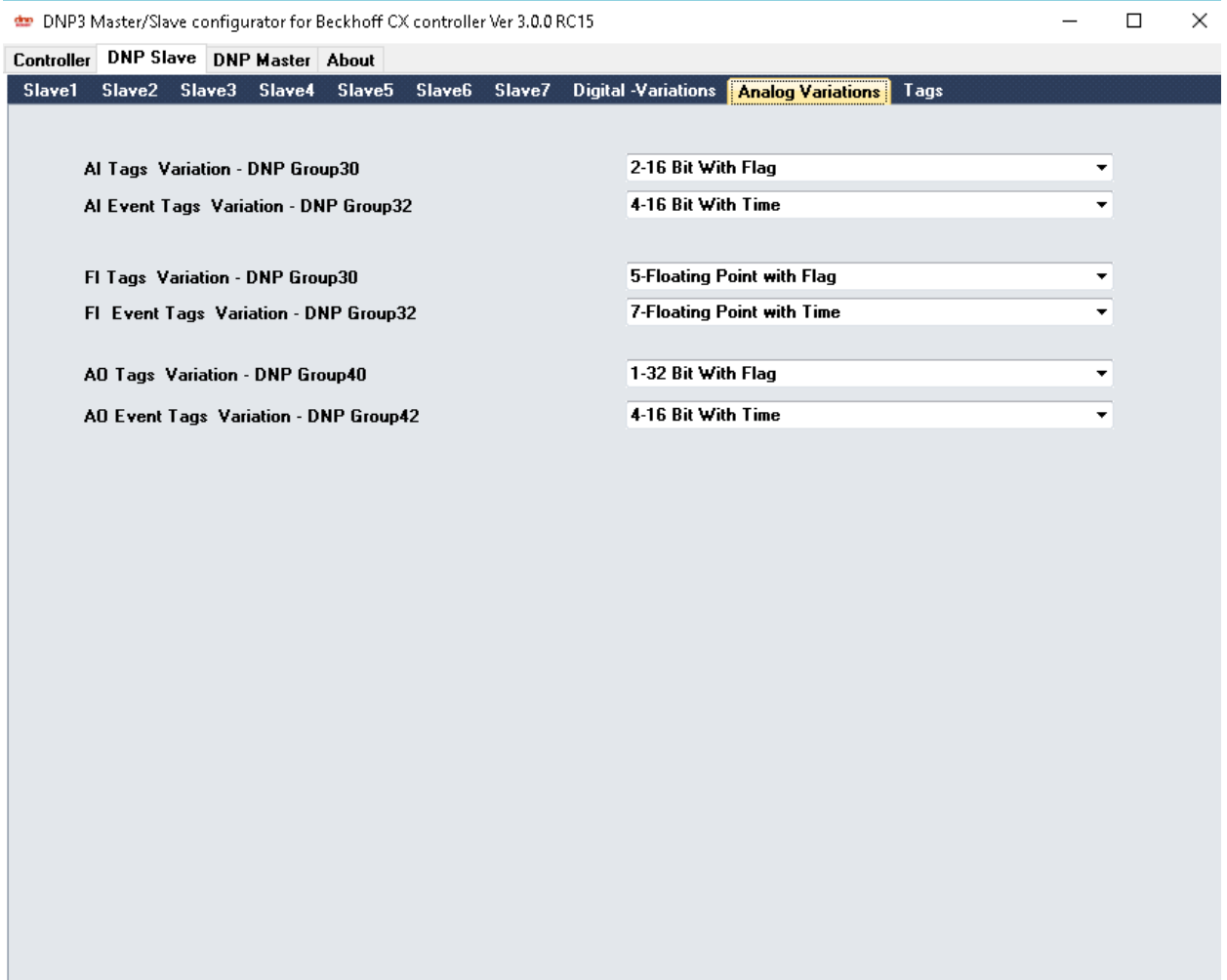
For following command default variation will use:

- Master is asking for class 0 tags
- Master is asking for class 1 tags
- Master is asking for class 2 tags
- Master is asking for class 3 tags
- Master is Sending Integrity poll (IP) Means master is asking class 0 , 1, 2 and 3 in one request

- Master is Sending RBE (Read Events) means Master is asking class 1, 2 and 3 in one request. Master wants to read only tags changes, not static value of all tags.
- Unsolicited communication. When Slave is sending tag changes to master without master request.
-

In DNP3 Configurator you can set default variation for Slave driver from digital-variation and analog –variation page.





Reading Tags from RTU :

For Reading Tags from TC ,you should do following tasks :

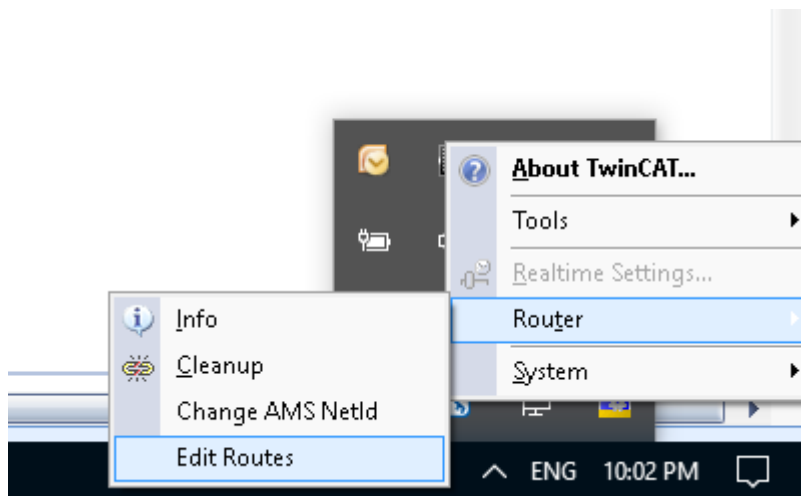
- Connect and define controller to TwinCAT System manager.
- TwinCat Runtime kernel is in runtime mode (Not configuration Mode)
- Write TwinCat PLC program and define DNP3 Variables.
- Compile and load twinCat Program to controller.

For reading TwinCat Tags from controller and configuration of tags for DNP3 protocol, you should use Tags Page.

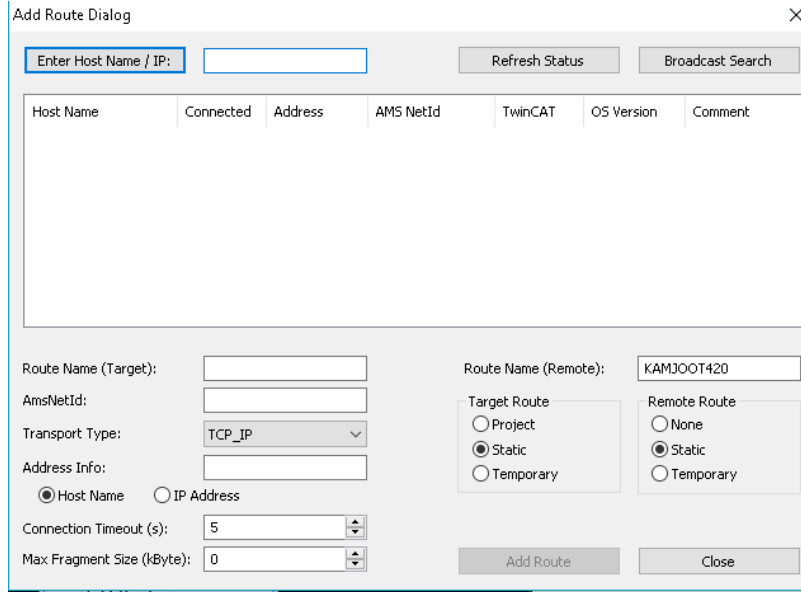
Active	Tag Name	Tag Comm...	Type	Group	Group Offset	GroupLen	DNP Type	DNPClass	DNPAddress
<input checked="" type="checkbox"/>	.DNP3_AI1		DINT	61488	0	4	AI	2	1
<input checked="" type="checkbox"/>	.DNP3_AI2		DINT	61488	4	4	AI	2	2
<input checked="" type="checkbox"/>	.DNP3_AI3		DINT	61488	8	4	AI	2	3
<input checked="" type="checkbox"/>	.DNP3_AI4		DINT	61488	12	4	AI	2	4
<input checked="" type="checkbox"/>	.DNP3_AI5		DINT	61488	16	4	AI	2	5
<input checked="" type="checkbox"/>	.DNP3_AI6		DINT	61488	20	4	AI	2	6
<input checked="" type="checkbox"/>	.DNP3_AI7		DINT	61488	24	4	AI	2	7
<input checked="" type="checkbox"/>	.DNP3_AI8		DINT	61488	28	4	AI	2	8
<input checked="" type="checkbox"/>	.DNP3_AI9		DINT	61488	32	4	AI	2	9
<input checked="" type="checkbox"/>	.DNP3_AI10		DINT	61488	36	4	AI	2	10
<input checked="" type="checkbox"/>	.DNP3_AO...		DINT	61472	0	4	AOB	1	1
<input checked="" type="checkbox"/>	.DNP3_AO...		DINT	61472	4	4	AOB	1	2
<input checked="" type="checkbox"/>	.DNP3_AO...		DINT	61472	8	4	AOB	1	3
<input checked="" type="checkbox"/>	.DNP3_AO...		DINT	61472	12	4	AOB	1	4
<input checked="" type="checkbox"/>	.DNP3_CN...		UDINT	16448	40	4	CNT	1	1
<input checked="" type="checkbox"/>	.DNP3_CN...		UDINT	16448	44	4	CNT	1	2
<input checked="" type="checkbox"/>	.DNP3_CN...		UDINT	16448	48	4	CNT	1	3
<input checked="" type="checkbox"/>	.DNP3_CN...		UDINT	16448	52	4	CNT	1	4
<input checked="" type="checkbox"/>	.DNP3_CN...		UDINT	16448	56	4	CNT	1	5
<input checked="" type="checkbox"/>	.DNP3_CN...		UDINT	16448	60	4	CNT	1	6
<input checked="" type="checkbox"/>	.DNP3_CN...		UDINT	16448	64	4	CNT	1	7
<input checked="" type="checkbox"/>	.DNP3_CN...		UDINT	16448	68	4	CNT	1	8
<input checked="" type="checkbox"/>	.DNP3_CN...		UDINT	16448	72	4	CNT	1	9
<input checked="" type="checkbox"/>	.DNP3_CN...		UDINT	16448	76	4	CNT	1	10
<input checked="" type="checkbox"/>	.DNP3_DI1		BOOL	61489	640	1	DI	1	1
<input checked="" type="checkbox"/>	.DNP3_DI2		BOOL	61489	641	1	DI	1	2

For reading tags from CX Controller, right click on Tags page and execute read tags from controller. It will read all TwinCat Tags from controller that start with Filter field. Because there are many systematic tags inside CX Controllers, so it is better to define DNP3 tags for your logic and start them with DNP3 name, then you can read just DNP3 tags by configurator and make setting for each tag.

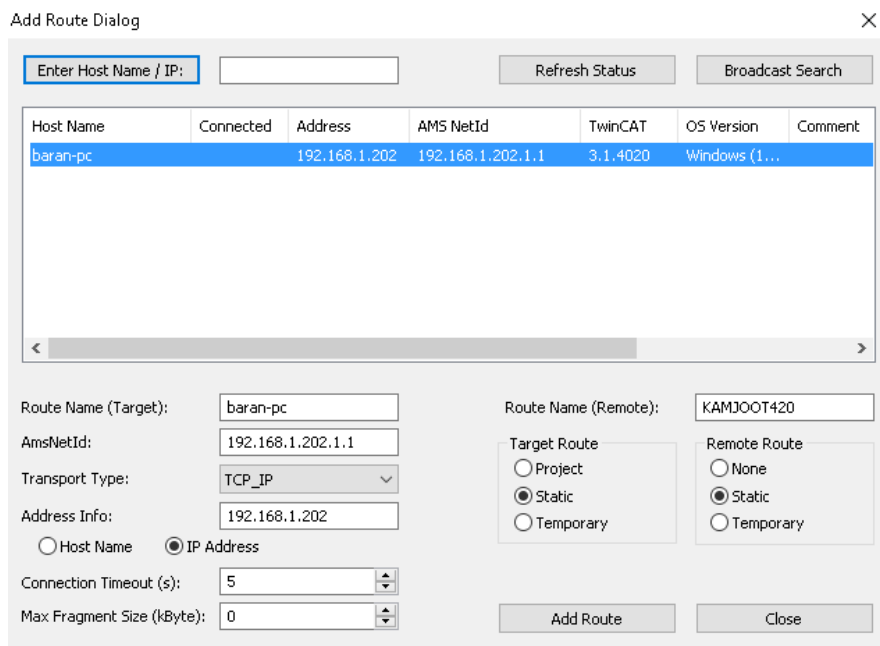
Important Point: you should Install TC ADS Utility in engineering station and add Controller AMSID in to router table of engineering station. Otherwise you will get Timeout when you want to read tags from controller.



When you run Edit Routers and click on add Button you will see following figure :

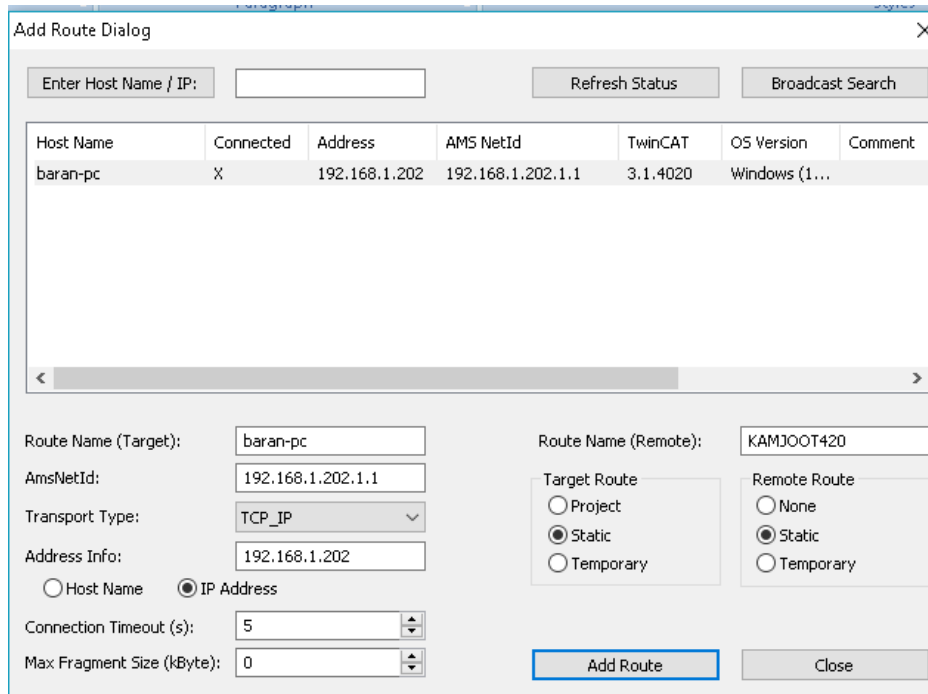


Normally it is better to set Address Info on IP Address and click on Broadcast search as following :



Click on Add Route, you need to enter User name and password of the target with administrator right:

If route is add properly, you will see X sign in Connected part:



Now you can run DNP3 Configurator and read tags from Controller .

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 32 , Variation 5
- 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
- FOB : Float Output Block , Group 41
- SYS: System Tag for monitoring Master Connection status for TCP connection. When you have two master , first SYS tag will link to first driver instance and second SYS tag will link to second driver instance.SYS Tags are using same DNP Address Space like AOB Tags . So you should not have any AOB Tags with Same DNP Address for SYS Tags .

- WDT: System Tag for making watch dog signal for TwinCat runtime.

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

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 there is no different or priority between different classes. So if you put class 1,2,3 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.

DNP3 function codes which are implemented:

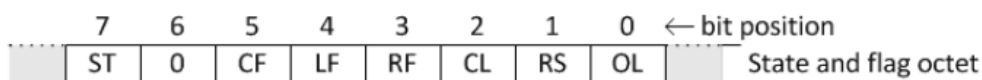
- Read class 0,1,2,3
- Integrity command
- Read Event by exception (RBE)
- Time synchronization
- Enable /Disable unsolicited communications (Transfer data from RTU to Master SCADA)
- Dynamic Class assign

- Freezing counters
- Write

DNP Tag Status:

In DNP3 Standard , any tag has status flag byte. Bit 0 shows Tag is online or not . Value 1 shows tag is online ad Value 0 Shows tag is offline . Other bits are as following:

DI Tag Status Flag:



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.

If you want to set DNP Tag Status Flag for driver you should define DIS , AIS , FIS , CNTS and DPIS Tags .

If did not define Status tag for a DNP Tag , Its Flag value is always 1 .

Suppose you define DNP Tag with type DI and address 10 , then if you define DIS Tag with same DNP Address 10 , then DIS Tag Value will use as Status flag of DI Tag .

Look at following code in TC :

```

0001 VAR_GLOBAL
0002
0003     DNP3_AI1 AT %Q* : DINT ;
0004     DNP3_AI2 AT %Q* : DINT ;
0005     DNP3_AI3 AT %Q* : DINT ;
0006     DNP3_AI4 AT %Q* : DINT ;
0007     DNP3_AI5 AT %Q* : DINT ;
0008     DNP3_AI6 AT %Q* : DINT ;
0009     DNP3_AI7 AT %Q* : DINT ;
0010     DNP3_AI8 AT %Q* : DINT ;
0011
0012     DNP3_AI9 AT %Q* : DINT ;
0013     DNP3_AI10 AT %Q* : DINT ;
0014
0015
0016     DNP3_AI1Status AT %Q* : INT ;
0017     DNP3_AI9Status AT %Q* : INT ;
0018

```

Two Status Tag for DNP3_AI1 and DNP3AI9 is defined in above sample . DNP Status Flag always has type int for DIS , AIS , FIS , CNTS, DPIS .

In DNP3 Configurator we will do following configuration for Status Tags:

<input checked="" type="checkbox"/>	.DNP3_AI1STATUS	INT16	16448	1690	2	AIS	1	1
<input checked="" type="checkbox"/>	.DNP3_AI9STATUS	INT16	16448	1692	2	AIS	1	9

And Following configuration for DNP Tags :

<input checked="" type="checkbox"/>	.DNP3_AI1	DINT	61488	0	4	AI	1	1
<input checked="" type="checkbox"/>	.DNP3_AI10	DINT	61488	36	4	AI	1	10
<input checked="" type="checkbox"/>	.DNP3_AI2	DINT	61488	4	4	AI	1	2
<input checked="" type="checkbox"/>	.DNP3_AI3	DINT	61488	8	4	AI	1	3
<input checked="" type="checkbox"/>	.DNP3_AI4	DINT	61488	12	4	AI	1	4
<input checked="" type="checkbox"/>	.DNP3_AI5	DINT	61488	16	4	AI	1	5
<input checked="" type="checkbox"/>	.DNP3_AI6	DINT	61488	20	4	AI	1	6
<input checked="" type="checkbox"/>	.DNP3_AI7	DINT	61488	24	4	AI	1	7
<input checked="" type="checkbox"/>	.DNP3_AI8	DINT	61488	28	4	AI	1	8
<input checked="" type="checkbox"/>	.DNP3_AI9	DINT	61488	32	4	AI	1	9

As it is clear , Status Tags and DNP Tags has same DNP Address .

In TC when you change value of DNP3_AI1Status , this value will pass to DNP Kernel and will assign for DNP_AI1 Tag as status flag . When value of Tags (DNP3_AI1Status or DNP3_AI1) is changed , DNP kernel will make an Event in Kernel .

So when Tag status changed , tag value with new status will report to master SCADA .

DNP3 Slave driver Operation:

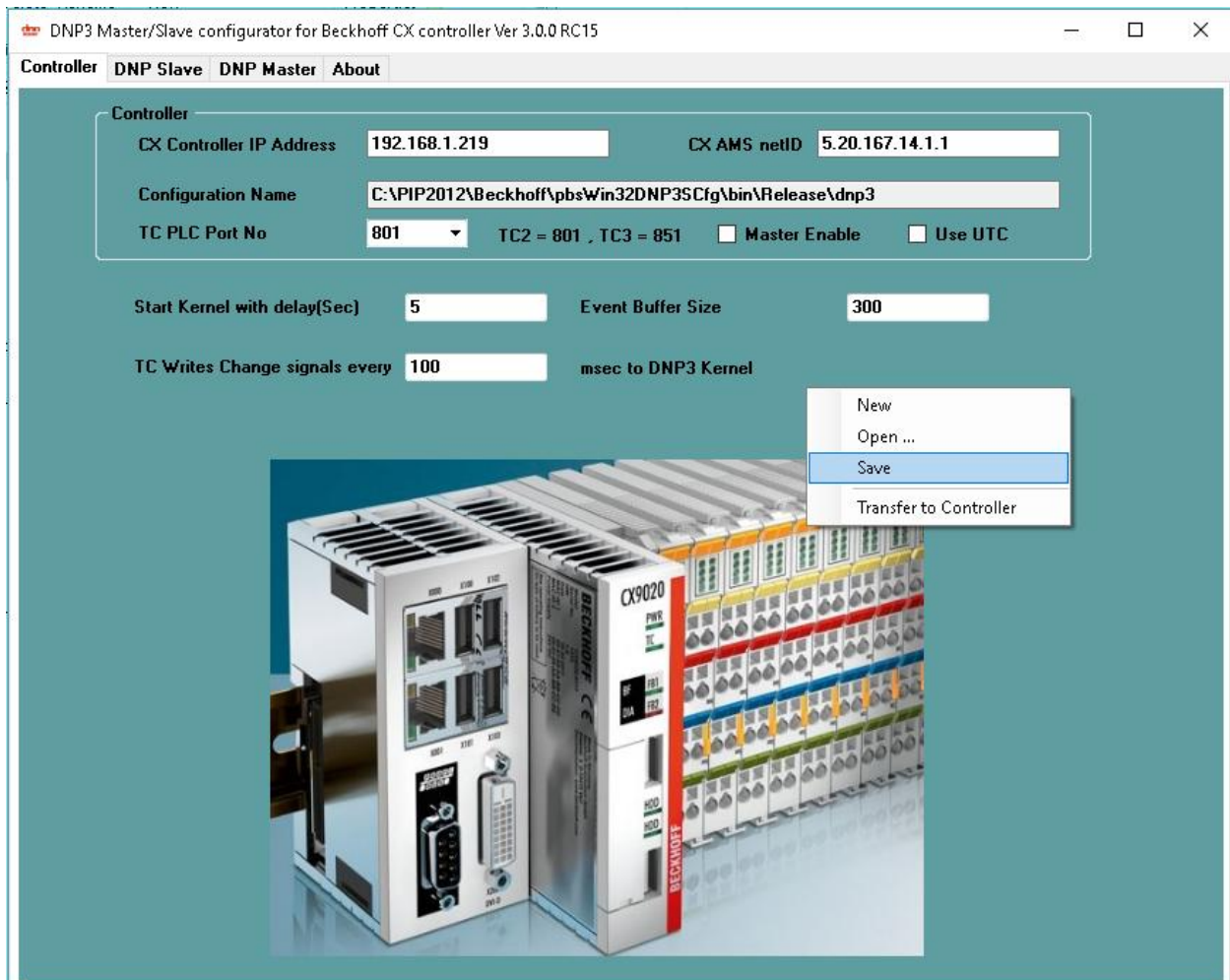
1 - Master SCADA will read all Input Signals (DI , AI , FI , DO , AO , DPI)

- You need to write all Input Signals in your logic by TC

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

- You need to read all Output Tags in your logic by TC

For saving configuration file to a local file on your PC, select Controller page, and right click. You can see following menu:



Open ...: open offline configuration file for editing.

Save: save opened configuration file.

Transfer to Controller: Transfer configuration file to controller.

4 – TwinCat programming

You need to define DNP3 tags in TwinCat programming environment as following sample. (DNP Slave Tags)

```
0001 VAR_GLOBAL
0002 (*AI, DI, FI, CNT Tag Definition*)
0003     DNP3_AI1 AT %Q*: DINT;
0004     DNP3_AI2 AT %Q*: DINT;
0005     DNP3_AI3 AT %Q*: DINT;
0006
0007     DNP3_FI4 AT %Q*: REAL;
0008     DNP3_FI5 AT %Q*: REAL;
0009     DNP3_FI6 AT %Q*: REAL;
0010
0011     DNP3_DI1 AT %Q*: BOOL;
0012     DNP3_DI2 AT %Q*: BOOL;
0013     DNP3_DI3 AT %Q*: BOOL;
0014
0015     DNP3_DO1 AT %Q*: BOOL;
0016     DNP3_DO2 AT %Q*: BOOL;
0017     DNP3_DO3 AT %Q*: BOOL;
0018
0019     DNP3_DPI1 AT %Q*: INT;
0020     DNP3_DPI2 AT %Q*: INT;
0021     DNP3_DPI3 AT %Q*: INT;
0022
0023     DNP3_CNT1 AT %Q*: UDINT;
0024     DNP3_CNT2 AT %Q*: UDINT;
0025     DNP3_CNT3 AT %Q*: UDINT;
0026
0027     DNP3_AO1 AT %Q*: DINT;
0028     DNP3_AO2 AT %Q*: DINT;
0029     DNP3_AO3 AT %Q*: DINT;
0030
0031 (*AOB, DOB Tag Definition*)
0032
0033     DNP3_SP1_WAT %I*: DINT;
0034     DNP3_SP2_WAT %I*: DINT;
0035     DNP3_SP3_WAT %I*: DINT;
0036     DNP3_SP4_WAT %I*: DINT;
0037
0038     DNP3_DOB1_WAT %I*: BOOL;
0039     DNP3_DOB2_WAT %I*: BOOL;
0040     DNP3_DOB3_WAT %I*: BOOL;
0041     DNP3_DOB4_WAT %I*: BOOL;
0042 END_VAR
0043
```

Rule 1: You should update (Write) DI, AI, FI, CNT and DPI Tags in your logic. DNP3 Inputs Tags (DI, AI, FI, CNT, and DPI) should be defining as output variables in TwinCat.

Rule 2: You should read AOB ,DOB,FOB tags in your logic.

AOB is analog Output Block and DOB is digital Output Block. FOB is Float Output Block. AOB and FOB use same address space . When SCADA Master wants to write AO,FO and DO tags to Controller, you should define DNP3 AOB,FOB and DOB Tag type. In TwinCat AOB,FOB and DOB tags should define as input Variables.

Rule 3: It is advised to define DNP3 Variables in TwinCat by DNP3 prefix. Then you can easily read DNP3 variables by DNP3 configurator utility.

Rule 4: you can define maximum 1024 DNP Tags

Rule 5: You should read TwinCat DNP3 Variables by DNP3 configurator utility and set DNP3 Type, Class and address. Please look at following figure as an example.

Controller DNP Slave DNP Master About									
Slave1 Slave2 Slave3 Slave4 Slave5 Slave6 Slave7 Digital Variations Analog Variations Tags									
Filter [Tag Name start with] .DNP3									
Active	Tag Name	Tag Comment	Type	Group	Group Offset	Group Len	DNPTType	DNPClass	DNPAddress
<input checked="" type="checkbox"/>	.DNP3_DI3		BOOL	61489	642	1	DI	1	3
<input checked="" type="checkbox"/>	.DNP3_DI4		BOOL	61489	643	1	DI	1	4
<input checked="" type="checkbox"/>	.DNP3_DI5		BOOL	61489	644	1	DI	1	5
<input checked="" type="checkbox"/>	.DNP3_DI6		BOOL	61489	645	1	DI	1	6
<input checked="" type="checkbox"/>	.DNP3_DI7		BOOL	61489	646	1	DI	1	7
<input checked="" type="checkbox"/>	.DNP3_DI8		BOOL	61489	647	1	DI	1	8
<input checked="" type="checkbox"/>	.DNP3_DI9		BOOL	61489	648	1	DI	1	9
<input checked="" type="checkbox"/>	.DNP3_D01_W		BOOL	61473	128	1	DOB	1	1
<input checked="" type="checkbox"/>	.DNP3_D02_W		BOOL	61473	129	1	DOB	1	2
<input checked="" type="checkbox"/>	.DNP3_D03_W		BOOL	61473	130	1	DOB	1	3
<input checked="" type="checkbox"/>	.DNP3_D04_W		BOOL	61473	131	1	DOB	1	4
<input checked="" type="checkbox"/>	.DNP3_DPI1		INT16	61488	124	2	DPI	1	1
<input checked="" type="checkbox"/>	.DNP3_DPI10		INT16	61488	142	2	DPI	1	10
<input checked="" type="checkbox"/>	.DNP3_DPI2		INT16	61488	126	2	DPI	1	2
<input checked="" type="checkbox"/>	.DNP3_DPI3		INT16	61488	128	2	DPI	1	3
<input checked="" type="checkbox"/>	.DNP3_DPI4		INT16	61488	130	2	DPI	1	4
<input checked="" type="checkbox"/>	.DNP3_DPI5		INT16	61488	132	2	DPI	1	5
<input checked="" type="checkbox"/>	.DNP3_DPI6		INT16	61488	134	2	DPI	1	6
<input checked="" type="checkbox"/>	.DNP3_DPI7		INT16	61488	136	2	DPI	1	7
<input checked="" type="checkbox"/>	.DNP3_DPI8		INT16	61488	138	2	DPI	1	8
<input checked="" type="checkbox"/>	.DNP3_DPI9		INT16	61488	140	2	DPI	1	9
<input checked="" type="checkbox"/>	.DNP3_FI1		REAL	61488	40	4	FI	1	11
<input checked="" type="checkbox"/>	.DNP3_FI10		REAL	61488	76	4	FI	1	20
<input checked="" type="checkbox"/>	.DNP3_FI2		REAL	61488	44	4	FI	1	12
<input checked="" type="checkbox"/>	.DNP3_FI3		REAL	61488	48	4	FI	1	13
<input checked="" type="checkbox"/>	.DNP3_FI4		REAL	61488	52	4	FI	1	14
<input checked="" type="checkbox"/>	.DNP3_FI5		REAL	61488	56	4	FI	1	15

NOTE : When you change Variables in TC (Add or delete or change Data type) , sometimes TC is changing Tags Group – Group Offset and Group Len internally . So you need to refresh Tags in Configurator for proper running of DNP Kernel. Otherwise DNP Tags value will not update in TC .

5 – System Tags

SYS: From Version 3 RC23 , we changed mechanism for SYS and WDT Tags . SYS tag is showing Connection Status with master SCADA. When Master is connected to Driver, SYS tag value is 1 and when it is disconnect, SYS Tag Value will change to 0.

By SYS tag, twinCat Runtime kernel will find status of connection. When you have two DNP3 master SCADA , you need to define two SYS tag with different DNP3 Address .

DNP3 Address for Instance 1 of DNP Slave driver MUST be 1.

DNP3 Address for Instance 2 of DNP Slave driver MUST be 2.

DNP3 Address for Instance 3 of DNP Slave driver MUST be 3.

DNP3 Address for Instance 4 of DNP Slave driver MUST be 4.

DNP3 Address for Instance 5 of DNP Slave driver MUST be 5.

DNP3 Address for Instance 6 of DNP Slave driver MUST be 6.

DNP3 Address for Instance 7 of DNP Slave driver MUST be 7.

Define an INT Tag in Twincat for SYS as following:

```
DNP3_SYS AT %I*:DINT;  
DNP3_WDT AT %I*:DINT;
```

After transferring configuration to Controller, and restart it, you can see status of DNP3 master connection in DNP3_SYS tag in Twincat runtime.

WDT: Watch Dog Timer Tag. With WDT Tag, TwinCat Runtime will find healthy status of Driver. WDT Tag makes a permanent 10 Sec Pulse for TwinCat. As TwinCat Runtime is detecting 10 Sec Pulse, DNP3 Driver is working properly. When TwinCat is not getting 10 Sec Pulse Train, Something is happened in Driver and needs to restart Controller by TwinCAT.

WDT Tag is working in TCP and Serial Mode communication and it is independent of Master SCADA Connection.

WDT Tag DNP Address can be any value expect 0 . if it is 0 it is disabled .

Define an INT Tag in Twincat for WDT as following:

```
DNP3_SYS AT %I*:DINT;  
DNP3_WDT AT %I*:DINT;
```

After transferring configuration to Controller, and restart it, you can see DNP3 Driver start to write a 10 sec permanent pulse train to TwinCAT.

DNP Group 50 (Date Time) , 60 (Class) , 80 (IIN) are supported in Driver but no need to do any configuration for this Groups .

ADS Reconnecting

It is possible that ADS connection with DNP Kernel is lost inside CX controller. DNP Kernel will reconnect to ADS at following condition:

- DNP Kernel writes to TC by ADS and it makes error at write time.
- There is no any write from TC to DNP kernel for 3600 Sec.

So we advise to define WDT tag for DNP Kernel for not reconnecting to ADS after 3600 Sec if there is really no write from TC to DNP Kernel.

In Some projects Tags are not changing frequently, so maybe there is no any write from TC to DNP kernel, but ADS connection is not lost with DNP Kernel. For these projects using WDT signal is necessary to stop frequent reconnecting of ADS link with DNP Kernel.

6 – DNP3 Master Configuration

From Version 3 RC5 DNP3 Kernel supports DNP3 Master Protocol. You can connect to DNP3 Slave RTUS over RS232 or TCP and read /Write tags to external RTUS.

Suppose there is an old RTU with DNP3 Slave Functionality over RS232, then you can use CX controller as a gateway to convert it to DNP over TCP.

At Controller page, Enable Master Functionality:

DNP3 Master/Slave configurator for Beckhoff CX controller Ver 3.0.0 RC22

Controller DNP Slave DNP Master About

Controller

CX Controller IP Address CX AMS netID

Configuration Name

TC PLC Port No TC2 = 801 , TC3 = 851 Master Enable Use UTC

Master RS485 Gateway Mode Gateway Wait msec

Start Kernel with delay(Sec)

TC Writes Change signals every msec to DNP3 Kernel



In DNP Master page you can see list of defined DNP3 Slave RTUS :

RTUName	Master ID	RTUID	Physical Layer	RTUIP	TCPPort	Serial Port	Baud Rate	Time
RTU1	1	3	TCP	192.168.1.13	20000	1	19200	15
RTU2	1	3	RS232	192.168.1.14	20000	1	19200	15

You can edit all RTU parameters from List .

By right click on list you can switch between list or card view for Slave RTU parameters.

For defining New RTU , it is more easy to go to New RTU Page :

DNP3 Master/Slave configurator for Beckhoff CX controller Ver 3.0.0 RC22

Controller DNP Slave DNP Master About

RTUs **New RTU**

RTU Enable

RTU Name Should be Unique . TC tag Name should contain RTU Name

Master ID

RTU ID

Enable Unsolicited Comm

Application Timeout (Sec)

Link Status (Sec) 0 = Disable

Integrity Poll Period (Min) 0 = Disable

RBE Period(Sec) 0 = Disable

Time Synch Period(Hour) 0 = Disable

Freeze Counters Period(Min) 0 = Disable

Read Class 0 Period(Sec) 0 = Disable

Default Command Mode

Diagnostic

Physical Layer

Serial Port COM

Serial BaudRate

RTU IP

TCP Port

Note :

1 - if you are using RS232 port for communication with Slave RTU you can link one RTU to one port only . It is peer to peer communication .

2 - Virtual COM Port by TC is also tested and supported

3 - Multi Drop RS485 network is supported in RS485 Gateway Mode

RTU Name : Select a unique Name for RTU . Suppose you select RTU3. Then All Tags in TC for RTU3 should be start with RTU3 . If you are using TC3 , then configurator will look for all TC tags that contains RTU Name .

Master ID : DNP3 Master ID

RTU ID : DNP3 Slave ID

Enable Unsolicited COMM : If checked when Master Driver Connect to RTU and after Reading Tags by Integrity poll , Will Enable Unsolicited communication in Slave RTU . After that Slave RTU will send all DNP Tag Changes to Master Without Master Request.

If unchecked Master Will Disable Unsolicited Communication in Slave RTU .

Application Timeout (Sec) : When Master is in Solicited Mode – Send Request to Slave and wait for answer - Master Driver will wait for above time to get answer , otherwise will move to Idle State and will be ready to handle next request .

Link Status (Sec) : When there is no communication with RTU for **Link Status** time , Master Will Send Link Status Command to RTU to check status of connection . If not get ACK , Master will disconnect connection with Slave and reconnect again . If 0 , it is Disabled .

Integrity Poll Period (Min) : Shows Sending IP command period to Slave in min . If 0 , it is Disable . If value is -1 , Master Driver is not send IP to Slave RTU at connection time

RBE Period (Sec) : Shows Sending RBE Command period to RTU in Sec . If 0, it is Disable .

Time Synch Period (Hour): Shows Sending Time Synch Command to RTU in Hour. If 0, it is Disabled .if -1 , DNP Master is not send Time Synch to RTU at connection time .

Freeze Counter Period (Min): Shows Sending Freeze Counters Command period to Slave RTU in Min. If 0, it is Disable .

Default Command Mode: Shows Default mode for DOB and AOB commands. Direct Operate or Select Before Operate .

Physical layer: Select TCP or RS232 . This is physical layer connection with Slave RTU.

For RS232 Connection you can only link one RTU to one Serial Port. Multi drop RS485 is supported but you need to Enable Master RS485 Gateway Mode.

Serial Port (COM) : This is COM number on Beckhoff CPU Module . Serial Ports that are connected by KBUS or EBUS are supported if you use proper TC driver for Virtual COM Port . Any COM port that is operating as Standard Serial port in WinCE can be used .

Baud rate : Serial Baud Rate for connection with RTU in RS232 Mode .

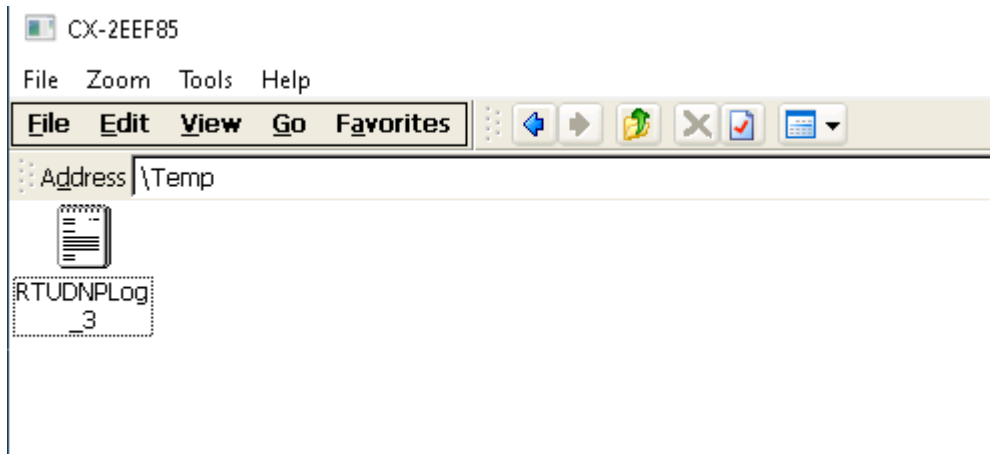
RTU IP : if you select TCP as communication layer you need to put RTU IP here .

TCP Port : if you select TCP as communication layer you need to put RTU TCP Port here . DNP Port is 20000

Diagnostic : if you want to analyze DNP Frames between CX Controller and Slave RTU , you can use this parameter . you can select from Disable , Physical Layer , Data Link Layer , Transport Layer and Application Layer options.

When Disable no DNP log File will generate.

When Set to Physical layer: only Physical layer Frames will log in a text file in CX \Temp \ Folder with name RTUDnpLog_{RTUID}



In following figure you can see one sample DNP Log file that is generated by DNP Master Driver:

```
physcial layer :Write To RTU:2019-12-24 3:58:59
,5 ,64 ,5 ,c0 ,3 ,0 ,1 ,0 ,76 ,9b

physcial layer :Read From RTU:2019-12-24 3:58:59
,5 ,64 ,5 ,0 ,1 ,0 ,3 ,0 ,f4 ,19

DLL Layer :GET from Physical:2019-12-24 3:58:59
5 64 5 0 1 0 3 0 f4 19

Transport Layer :GET From APP:2019-12-24 3:58:59
c0 2 32 1 7 1 fa d6 e 36 6f 1

DLL Layer :GET From Transport:2019-12-24 3:58:59
c0 c0 2 32 1 7 1 fa d6 e 36 6f 1

physcial layer :Write To RTU:2019-12-24 3:58:59
,5 ,64 ,12 ,c4 ,3 ,0 ,1 ,0 ,91 ,b1 ,c0 ,c0 ,2 ,32 ,1 ,7 ,1 ,fa ,d6 ,e ,36 ,6f ,1 ,47 ,7e

physcial layer :Read From RTU:2019-12-24 3:59:0
,5 ,64 ,a ,44 ,1 ,0 ,3 ,0 ,b4 ,e1 ,c0 ,c0 ,81 ,2 ,0 ,79 ,f3

DLL Layer :GET from Physical:2019-12-24 3:59:0
5 64 a 44 1 0 3 0 b4 e1 c0 c0 81 2 0 79 f3

Transport Layer :GET From DLL:2019-12-24 3:59:0
c0 c0 81 2 0
```

When you set Diagnostic to Data link layer , it will log physical and data link layer frames .

When you set Diagnostic to Transport layer , it will log physical , data link and transport layer frames .

When you set Diagnostic to Application layer , it will log all frames and all tags that is gathered from Application layer frame.

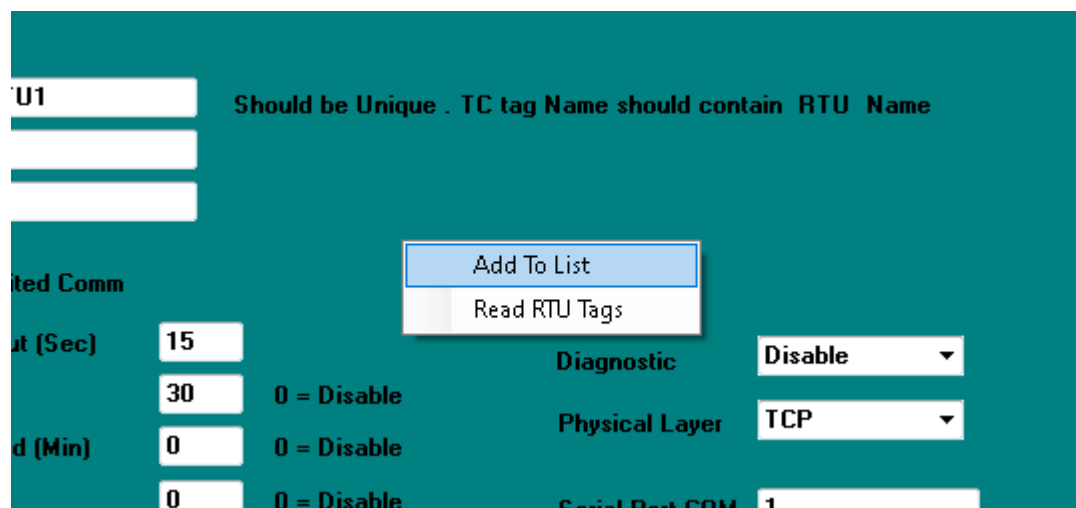
In following sample you can see frames with application layer Diagnostic option:

```

physical layer :Read From RTU:2019-12-24 4:21:36
,0,0,0,7,0,1,0,0,97,3c,0,0,8,0,1,0,0,0,0,9,0,1,0,0,0,0,67,b4,14,1,28,a,0,1,0,1,0,0,0,0,2,0,1,0,e8,f7,0,0,0,3,0,1,0,0,0
DLL Layer :GET from Physical:2019-12-24 4:21:36
0 0 0 7 0 1 0 0 97 3c 0 0 8 0 1 0 0 0 0 9 0 1 0 0 0 0 67 b4 14 1 28 a 0 1 0 1 0 0 0 0 2 0 1 0 e8 f7 0 0 0 3 0 1 0 0 0 0 4 0 1 0 0 0 ba 87 0 5 0 1 0 0 0 0 6 0 1 0 0 0 0 7 d4
Transport Layer :GET From DLL:2019-12-24 4:21:36
40 e3 81 0 0 2 2 28 3 0 1 0 81 44 12 9b 38 6f 1 1 0 1 ed 25 9b 38 6f 1 1 2 28 1d 0 1 0 81 2 0 1 3 0 1 4 0 1 5 0 1 6 0 1 7 0 1 8 0 1 9 0 1 a 0 1 b 0 1
Transport Layer :GET From DLL:2019-12-24 4:21:36
81 1 0 0 0 0 4 0 1 0 0 0 0 5 0 1 0 0 0 0 6 0 1 0 0 0 0 7 0 1 0 0 0 0 8 0 1 0 0 0 0 9 0 1 0 0 0 0 14 1 28 a 0 1 0 1 0 0 0 0 2 0 1 0 0 0 0 3 0 1 0 0 0 0 4 0 1 0 0 0 0 5 0 1 0
App Layer :GET From Transport:2019-12-24 4:21:36
e3 81 0 0 2 2 28 3 0 1 0 81 44 12 9b 38 6f 1 1 0 1 ed 25 9b 38 6f 1 1 2 28 1d 0 1 0 81 2 0 1 3 0 1 4 0 1 5 0 1 6 0 1 7 0 1 8 0 1 9 0 1 a 0 1 b 0 1 c
Transport Layer :GET From APP:2019-12-24 4:21:36
c3 0
TmpTagType = 1 ,Gr = 2 ,Var=2 ,Add =1 ,Val=1.000000 ,TL=1577202684 ,Tlms=484
TmpTagType = 1 ,Gr = 2 ,Var=2 ,Add =1 ,Val=0.000000 ,TL=1577202689 ,Tlms=517
TmpTagType = 1 ,Gr = 2 ,Var=2 ,Add =1 ,Val=1.000000 ,TL=1577202694 ,Tlms=549
TmpTagType = 1 ,Gr = 1 ,Var=2 ,Add =1 ,Val=1.000000 ,TL=0 ,Tlms=0
TmpTagType = 1 ,Gr = 1 ,Var=2 ,Add =2 ,Val=0.000000 ,TL=0 ,Tlms=0
TmpTagType = 1 ,Gr = 1 ,Var=2 ,Add =3 ,Val=0.000000 ,TL=0 ,Tlms=0
TmpTagType = 1 ,Gr = 1 ,Var=2 ,Add =4 ,Val=0.000000 ,TL=0 ,Tlms=0
TmpTagType = 1 ,Gr = 1 ,Var=2 ,Add =5 ,Val=0.000000 ,TL=0 ,Tlms=0
    
```

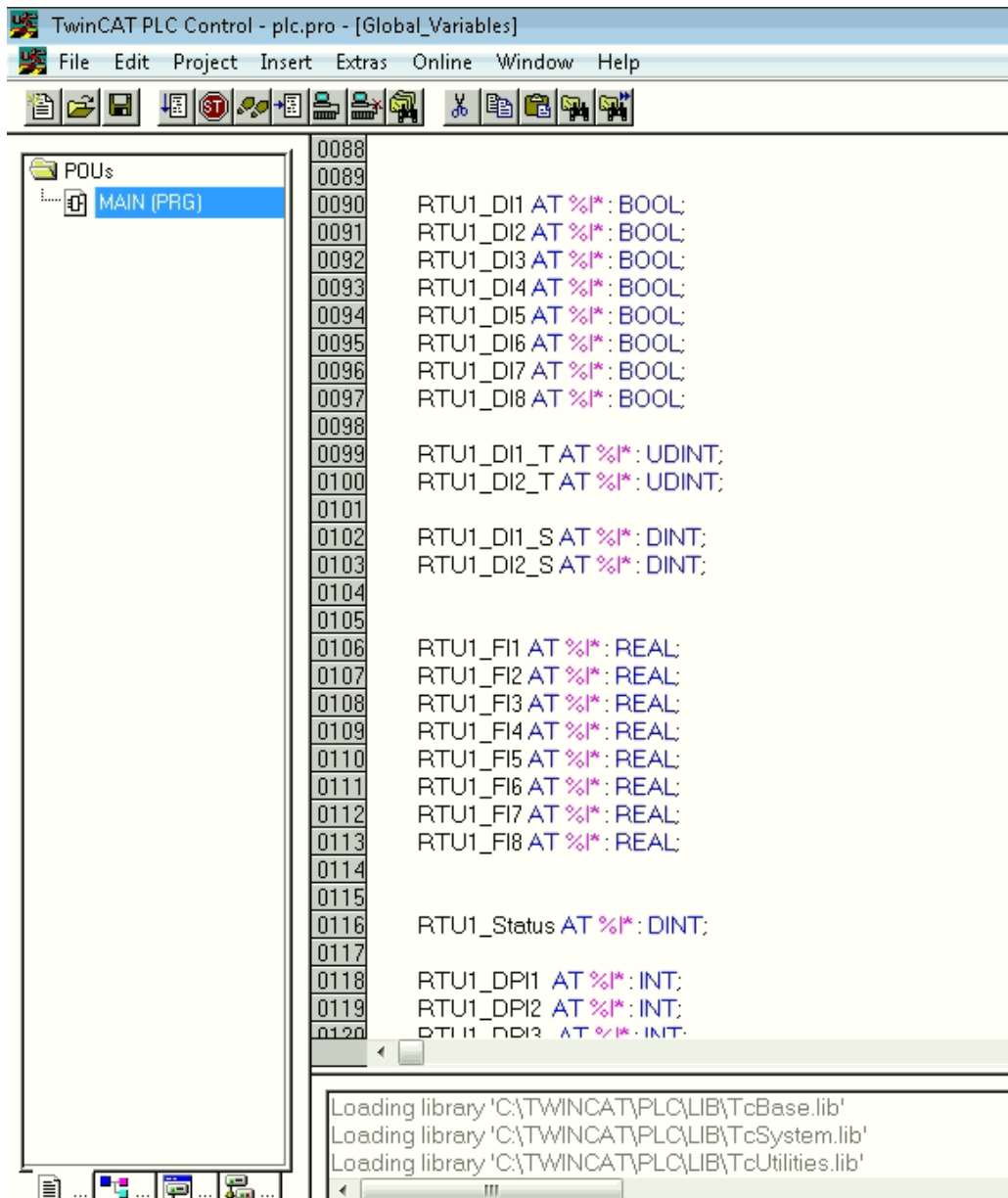
Always set Diagnostic to Disable for normal operation of Master Driver.

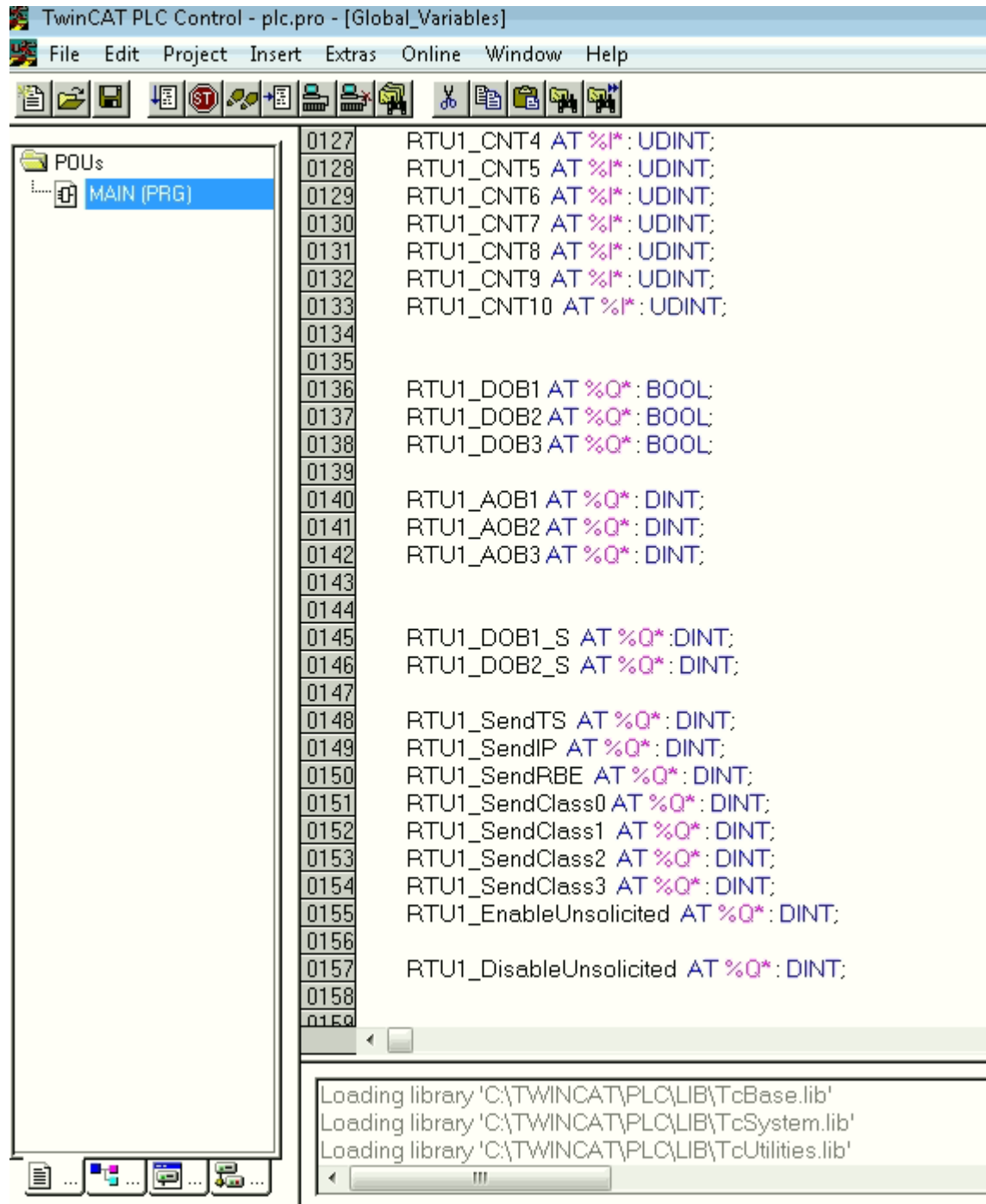
After setting above parameter right click on page and add RTU to list .



After adding RTU to List, if name of RTU is unique , it will add to RTU list . If you want to change above parameter ,directly change on List.

RTU Tags in TC : you should define DNP3 master RTU tags in TC as following Sample :





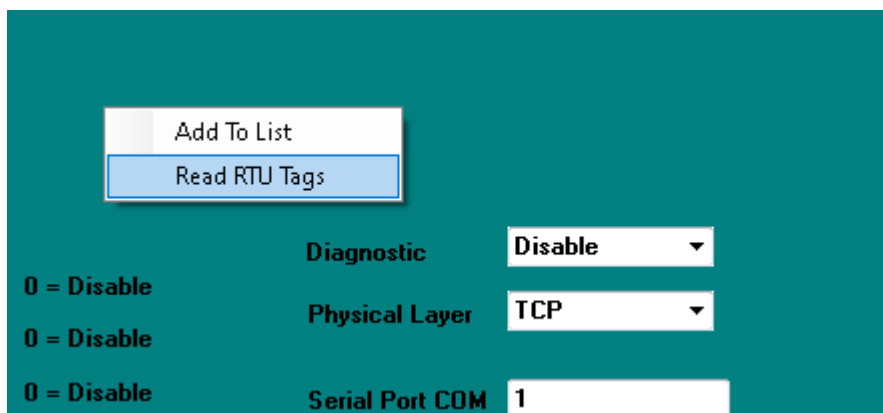
Define DI , AI , FI , DO , AO and DPI Tags as Input Tags to TC .

Define DOB and AOB as Output Tags.

After transferring Tags to CX Controller , you can read tags by DNP3 Configurator .

As you can see , Tag Names for one RTU ,starts with Same name that we put in Configurator for RTU .

For reading Tags in Configurator, go to New RTU Page, Write RTU name, Right Click and Execute “Read RTU Tags”



After Reading Tags , you can see all tags in RTU List .

DNP3 Master/Slave configurator for Beckhoff CX controller Ver 3.0.0 RC15

Controller | DNP Slave | DNP Master | About

RTUs | New RTU

RTUName	Master ID	RTUID	Physical Layer	RTUIP	TCPPort	Serial Port	Baud Rate	Time Out	E
RTU1	1	3	TCP	192.168.1.149	20000	1	19200	15	

RTUName	Tag Name	Tag ...	Type	Group	Group Offset	GroupLen	DNPTtype	DNPAddress
RTU1	.RTU1_AOB1		DINT	61488	144	4	AOB	1
RTU1	.RTU1_AOB2		DINT	61488	148	4	AOB	2
RTU1	.RTU1_AOB3		DINT	61488	152	4	AOB	3
RTU1	.RTU1_CNT1		UDINT	61472	76	4	CNT	1
RTU1	.RTU1_CNT10		UDINT	61472	112	4	CNT	10
RTU1	.RTU1_CNT2		UDINT	61472	80	4	CNT	2
RTU1	.RTU1_CNT3		UDINT	61472	84	4	CNT	3
RTU1	.RTU1_CNT4		UDINT	61472	88	4	CNT	4
RTU1	.RTU1_CNT5		UDINT	61472	92	4	CNT	5
RTU1	.RTU1_CNT6		UDINT	61472	96	4	CNT	6
RTU1	.RTU1_CNT7		UDINT	61472	100	4	CNT	7
RTU1	.RTU1_CNT8		UDINT	61472	104	4	CNT	8
RTU1	.RTU1_CNT9		UDINT	61472	108	4	CNT	9
RTU1	.RTU1_DI1		BOOL	61473	576	1	DI	1
RTU1	.RTU1_DI1_S		DINT	61472	156	4	DIS	1
RTU1	.RTU1_DI1_T		UDINT	61472	164	4	DIT	1
RTU1	.RTU1_DI2		BOOL	61473	577	1	DI	2
RTU1	.RTU1_DI2_S		DINT	61472	160	4	DIS	2
RTU1	.RTU1_DI2_T		UDINT	61472	168	4	DIT	2
RTU1	.RTU1_DI3		BOOL	61473	578	1	DI	3
RTU1	.RTU1_DI4		BOOL	61473	579	1	DI	4
RTU1	.RTU1_DI5		BOOL	61473	580	1	DI	5
RTU1	.RTU1_DI6		BOOL	61473	581	1	DI	6
RTU1	.RTU1_DI7		BOOL	61473	582	1	DI	7
RTU1	.RTU1_DI8		BOOL	61473	583	1	DI	8
RTU1	.RTU1_DOB1		BOOL	61489	1248	1	DOB	1
RTU1	.RTU1_DOB1_S		DINT	61488	160	4	DOBS	1
RTU1	.RTU1_DOB2		BOOL	61489	1249	1	DOB	2
RTU1	.RTU1_DOB2_S		DINT	61488	164	4	DOBS	2
RTU1	.RTU1_DOB3		BOOL	61489	1250	1	DOB	3
RTU1	.RTU1_DPI1		INT16	61472	64	2	DPI	1

You should set DNP Type and DNP Address for each tag .

DI = Digital input

AI = Analog Input

FI = Float Input

DPI = Double Bit

DO = Digital Output Status

AO : Analog Output Status

DOB : Digital Output Block (Write Command)

AOB : Analog Output Block (Write Command)

System Tags with help of system tags you can manage RTU by DNP3 commands from TC .

SYS : System Tag

- SYS with DNP Address 1 = RTU Connection status
It is showing Connection Status with Slave RTU (Offline, Online, Connecting,...) value of this tag is 10 (connecting) , 11 (connected) , 20 (Send Time synch) , 30 (request data at startup) and finally 100 shows driver got dnp tags from salve RTU and Driver is online .
- SYS with DNP Address 2 = Send Time Synch Command to RTU
- SYS with DNP Address 3 = Send integrity Poll (IP) to RTU
- SYS with DNP Address 4 = Send RBE to RTU
- SYS with DNP Address 5 = Read tags with Class 0 from RTU
- SYS with DNP Address 6 = Read tags with Class 1 from RTU
- SYS with DNP Address 7 = Read tags with Class 2 from RTU
- SYS with DNP Address 8 = Read tags with Class 3 from RTU
- SYS with DNP Address 9 = Enable Unsolicited communication in RTU
- SYS with DNP Address 10 = Disable Unsolicited communication in RTU

- SYS with DNP Address 11 = Change Default Command Type to Direct Operate
- SYS with DNP Address 12 = Change Default Command Type to Select before Operate
-

SYS tag with Address 1 is read Only , but you should write other SYS tags .

Suppose you want to send Time synch from TC to RTU. Then you should write a pulse with width 5 Sec to SYS.SendTS signal (address 2) Driver will send Time Synch command when it detect rising Edge in System Tag value with Address 2.

Define system tags in TC as following sample :

```

RTU1_SendTS AT %Q*: DINT;
RTU1_SendIP AT %Q*: DINT;
RTU1_SendRBE AT %Q*: DINT;
RTU1_SendClass0 AT %Q*: DINT;
RTU1_SendClass1 AT %Q*: DINT;
RTU1_SendClass2 AT %Q*: DINT;
RTU1_SendClass3 AT %Q*: DINT;
RTU1_EnableUnsolicited AT %Q*: DINT;
RTU1_DisableUnsolicited AT %Q*: DINT;

```

Then link them in DNP Configurator as following:

RTU1	.RTU1_STATUS	DINT	61472	60	4	SYS	1
RTU1	.RTU1_DISABLEUNSOLICITED	DINT	61488	200	4	SYS	10
RTU1	.RTU1_ENABLEUNSOLICITED	DINT	61488	196	4	SYS	9
RTU1	.RTU1_SENDCCLASS0	DINT	61488	180	4	SYS	5
RTU1	.RTU1_SENDCCLASS1	DINT	61488	184	4	SYS	6
RTU1	.RTU1_SENDCCLASS2	DINT	61488	188	4	SYS	7
RTU1	.RTU1_SENDCCLASS3	DINT	61488	192	4	SYS	8
RTU1	.RTU1_SENDIP	DINT	61488	172	4	SYS	3
RTU1	.RTU1_SENDRBE	DINT	61488	176	4	SYS	4
RTU1	.RTU1_SENDS	DINT	61488	168	4	SYS	2

Defining Tag Flag and Time Label:

You can read DNP Master tags Flag and Time label in TC by {X}S and {X}T Data type (DIS , AIS , DPIS , FIS ,CNTS, DIT, AIT , DPIT , FIT ,CNTT)

DNP Address of Tag Should be same as {X}S /{X}T Tag. Look at following sample :

In TC we defined following tags :

0088	
0089	
0090	RTU1_DI1 AT %I*: BOOL;
0091	RTU1_DI2 AT %I*: BOOL;
0092	RTU1_DI3 AT %I*: BOOL;
0093	RTU1_DI4 AT %I*: BOOL;
0094	RTU1_DI5 AT %I*: BOOL;
0095	RTU1_DI6 AT %I*: BOOL;
0096	RTU1_DI7 AT %I*: BOOL;
0097	RTU1_DI8 AT %I*: BOOL;
0098	
0099	RTU1_DI1_T AT %I*: UDINT;
0100	RTU1_DI2_T AT %I*: UDINT;
0101	
0102	RTU1_DI1_S AT %I*: DINT;
0103	RTU1_DI2_S AT %I*: DINT;
0104	

In configurator we will link same DNP Address for RTU_DI1 (Signal Value) , RTU_DI1_T (time Label) and RTU_DI_S (Flag) signals .

Time Label Tags are defined based on DNP Standard which is Linux epoch Time , msec from 1/1/1970 .

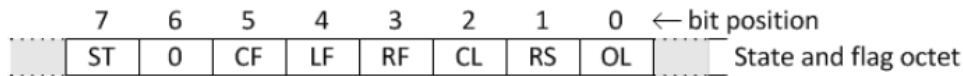
DNP3 Master/Slave configurator for Beckhoff CX controller Ver 3.0.0 RC15

Controller DNP Slave DNP Master About

RTUs New RTU

RTUName	Master ID	RTUID	Physical Layer	RTUIP	TCPPort	Serial Port	Baud Rate	Time Out	Enat
RTU1	1	3	TCP	192.168.1.149	20000	1	19200	15	
RTUName	Tag Name	Tag ...	Type	Group	Group Offset	GroupLen	DNPTyp	DNPAddress	D
RTU1	.RTU1_AOB1		DINT	61488	144	4	AOB	1	0
RTU1	.RTU1_AOB2		DINT	61488	148	4	AOB	2	0
RTU1	.RTU1_AOB3		DINT	61488	152	4	AOB	3	0
RTU1	.RTU1_CNT1		UDINT	61472	76	4	CNT	1	0
RTU1	.RTU1_CNT10		UDINT	61472	112	4	CNT	10	0
RTU1	.RTU1_CNT2		UDINT	61472	80	4	CNT	2	0
RTU1	.RTU1_CNT3		UDINT	61472	84	4	CNT	3	0
RTU1	.RTU1_CNT4		UDINT	61472	88	4	CNT	4	0
RTU1	.RTU1_CNT5		UDINT	61472	92	4	CNT	5	0
RTU1	.RTU1_CNT6		UDINT	61472	96	4	CNT	6	0
RTU1	.RTU1_CNT7		UDINT	61472	100	4	CNT	7	0
RTU1	.RTU1_CNT8		UDINT	61472	104	4	CNT	8	0
RTU1	.RTU1_CNT9		UDINT	61472	108	4	CNT	9	0
RTU1	.RTU1_DI1		BOOL	61473	576	1	DI	1	0
RTU1	.RTU1_DI1_S		DINT	61472	156	4	DIS	1	0
RTU1	.RTU1_DI1_T		UDINT	61472	164	4	DIT	1	0
RTU1	.RTU1_DI2		BOOL	61473	577	1	DI	2	0
RTU1	.RTU1_DI2_S		DINT	61472	160	4	DIS	2	0
RTU1	.RTU1_DI2_T		UDINT	61472	168	4	DIT	2	0
RTU1	.RTU1_DI3		BOOL	61473	578	1	DI	3	0
RTU1	.RTU1_DI4		BOOL	61473	579	1	DI	4	0
RTU1	.RTU1_DI5		BOOL	61473	580	1	DI	5	0
RTU1	.RTU1_DI6		BOOL	61473	581	1	DI	6	0
RTU1	.RTU1_DI7		BOOL	61473	582	1	DI	7	0
RTU1	.RTU1_DI8		BOOL	61473	583	1	DI	8	0
RTU1	.RTU1_DOB1		BOOL	61489	1248	1	DOB	1	0

In DNP3 Standard we have following Tag Flags :
Digital Input

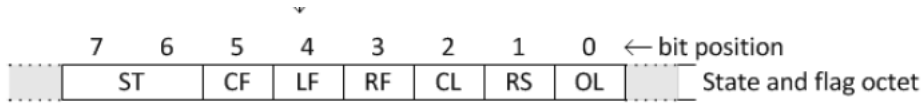


A.3.1.2.2 Formal structure

BSTR8: Flag Octet

- Bit 0: ONLINE
- Bit 1: RESTART
- Bit 2: COMM_LOST
- Bit 3: REMOTE_FORCED
- Bit 4: LOCAL_FORCED
- Bit 5: 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.

Double Bit Binary input :



A.4.2.2.2 Formal structure

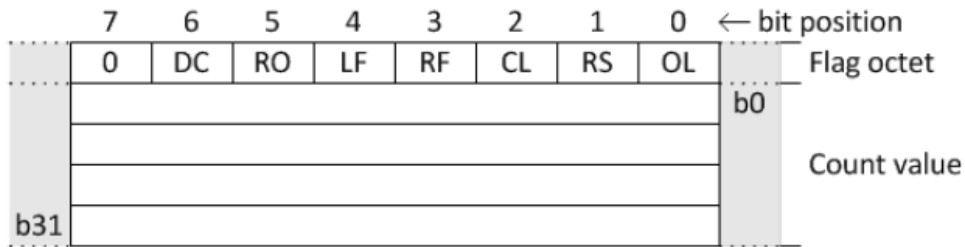
BSTR6: Flags

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.

Counters (16 Bit and 32 Bit Counter has identical Flag)



A.10.1.2.2 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:	ROLLOVER
Bit 6:	DISCONTINUITY
Bit 7:	Reserved, always 0.

Analog Input (Different variation has identical flag)



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.

Direct Mapping Between DNP Master and Slave Kernel

If you want to transfer DNP3 Tags from DNP Master Driver with msec time label to DNP3 Slave Kernel then you should not use ADS for mapping Tags.

For this scenario you can directly map Master tags to Slave Kernels.

3	TCP	192.168.1.106	20000	1	19200	15	<input checked="" type="checkbox"/>	20
ame	Tag Comment	Type	Group	Group Offset	GroupLen	DNPType	DNPAddress	DNPAddress Slave
_AOB1		DINT	61488	144	4		1	0
_AOB2		DINT	61488	148	4		1	0
_AOB3		DINT	61488	152	4		1	0
_CNT1		UDINT	61472	76	4		1	0
_CNT10		UDINT	61472	112	4		1	0
_CNT2		UDINT	61472	80	4		1	0
_CNT3		UDINT	61472	84	4		1	0
_CNT4		UDINT	61472	88	4		1	0
_CNT5		UDINT	61472	92	4		1	0
_CNT6		UDINT	61472	96	4		1	0
_CNT7		UDINT	61472	100	4		1	0
_CNT8		UDINT	61472	104	4		1	0
_CNT9		UDINT	61472	108	4		1	0
_DI1		BOOL	61473	576	1	DI	1	1
_DI1_S		DINT	61472	156	4	DIS	1	0
_DI1_T		UDINT	61472	164	4	DIT	1	0
_DI2		BOOL	61473	577	1	DI	2	2
_DI2_S		DINT	61472	160	4	DIS	2	0
_DI2_T		UDINT	61472	168	4	DIT	2	0
_DI3		BOOL	61473	578	1	DI	3	0
_DI4		BOOL	61473	579	1	DI	4	0
_DI5		BOOL	61473	580	1	DI	1	0

When you define DNP Master tags in Configurator , you can make direct link between dnp master and slave tags by DNPAddressSlave address .

In above example we mapped DI Tag with address 1 (Master Side) to DNP3 Slave tag with same Address 1 .

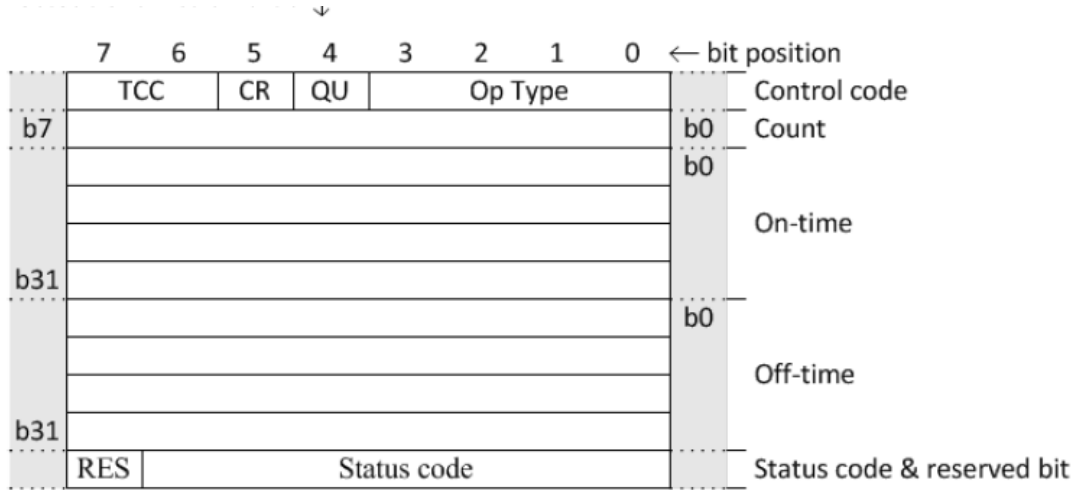
Then all SOE and changes for this tag will map directly to Slave Kernel .

There is no Direct map from Slave kernel to Master Kernel.

DOBS Data Type

By help of DOBS datatype you can write with different configuration from TC to Slave RTU.

First will look at DNP3 Digital output Block Data Type from Standard:



UINT4: Control code, Operation Type field [Op Type].

This field is used in conjunction with the *TCC* field to specify a control operation. See operational functions (A.8.1.3.2) for additional details. The code names are:

- 0: NUL
- 1: PULSE_ON
- 2: PULSE_OFF
- 3: LATCH_ON
- 4: LATCH_OFF
- 5 to 15: Undefined

BSTR1: Control code, Queue field [QU].

This field is obsolete. The master shall always set this bit to 0. Outstations that receive a g12v1 object with this bit set shall return a status code NOT_SUPPORTED in the response.

BSTR1: Control code, Clear field [CR].

Support for this field is optional. If the device supports commands with the clear bit set:

- It shall support the case where the Op Type code is NUL, and may support the command for other Op Type values.
- When the clear bit is set, the device shall remove pending control commands for that index and stop any control operation that is in progress for that index. The indexed point shall go to the state that it would have if the command were allowed to complete normally. If a non-NUL Op Type code is requested, the new command shall be initiated immediately after the cancellation actions complete.

When the clear bit is set and the *TCC* - Op Type combination is not supported, the device shall return status code NOT_SUPPORTED in the response.

UINT2: Control code, Trip-Close Code field [TCC].

This field is used in conjunction with the *Op Type* field to specify a control operation. See operational functions for additional details. The code names are

- 0: NUL
- 1: CLOSE
- 2: TRIP
- 3: RESERVED

UINT8: Count.

This is the number of times the outstation shall execute the operation. Counts greater than 1 generate a series of pulses or repeated operations for the point. Both *On-time* and *Off-time* values are obeyed as illustrated in the figures under timing illustrations, subject to the comments regarding timing in interpreting the time fields.

Implementation of a zero-count functionality is optional. A count value of 0 indicates that the output operation shall not be executed. Setting the count value to 0 is a useful technique for testing communications without affecting an output. When the outstation receives a 0 value, it shall:

- Not change the output.
- Ignore the On-time and Off-time values.
- Return the same status code as if the execution had been attempted.

An outstation shall return status code `NOT_SUPPORTED` in the response when the count value is 0 in the request and the outstation does not implement the zero-count functionality.

UINT32: On-time.

This is the duration, expressed as the number of milliseconds, that the output drive remains active. See interpreting the time fields for more details.

UINT32: Off-time.

This is the duration, expressed as the number of milliseconds that the output drive remains non-active. See interpreting the time fields for more details.

UINT7: Status code.

This value shall be set to 0 in request messages.

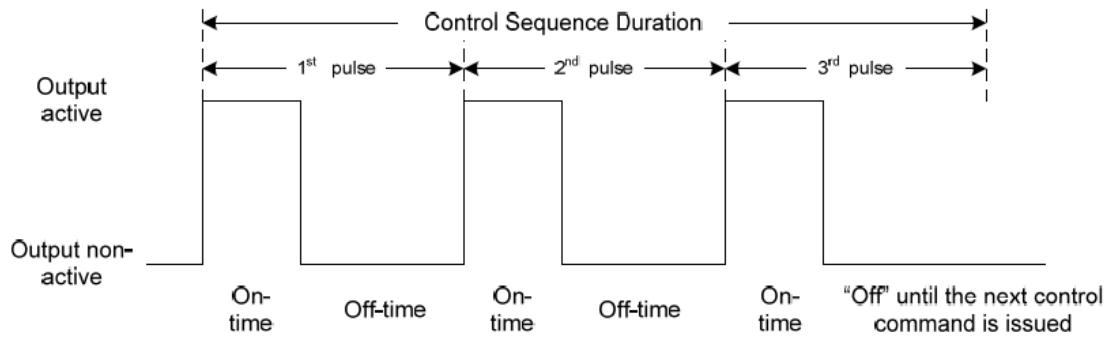
In response messages, this value represents the status of the selected or executed command. See [Table 11-7](#) for descriptions of control-related status codes.

BSTR1: Reserved [RES].

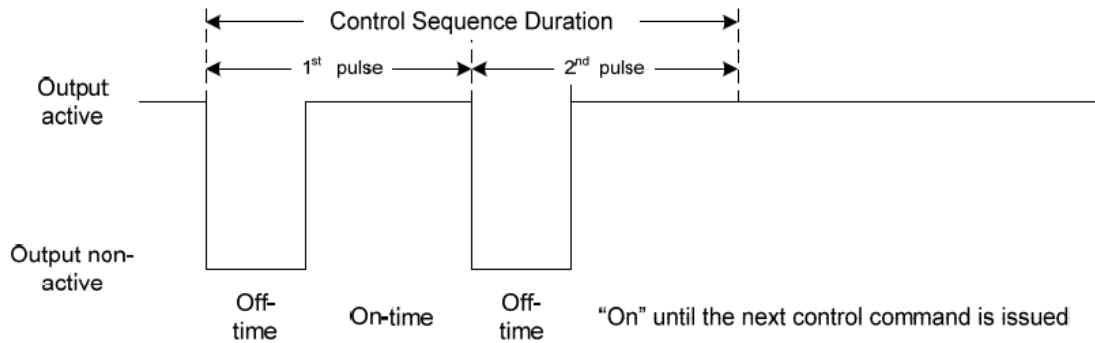
This bit is reserved. The master and outstation shall always set it to 0.

A.8.1.3.1 Timing illustrations

This subclause illustrates just two of the many timing possibilities that can appear in a g12v1 object.



PULSE ON with Count = 3



PULSE OFF with Count = 2 (Not interoperable)

A.8.1.3.2 Operational functions

A.8.1.3.2.1 Interoperable commands

Only a few of the 64 possible *TCC* and *Op Type* field bit combinations are interoperable. **Table A-1** indicates, for each point index, which commands are optional, preferred, not permitted, or not interoperable, depending on which point model is implemented.

Table A-1—Interoperable control commands

TCC field	Op Type field	Point model in outstation	Support requirements
NUL	NUL	All	Optional
NUL	PULSE_ON	Activation	May support
		Complementary latch	Not permitted
		Complementary two-output	Not permitted
NUL	LATCH_ON	Activation	May support
		Complementary latch	Preferred support
		Complementary two-output	May support
NUL	LATCH_OFF	Activation	May support
		Complementary latch	Preferred support
		Complementary two-output	May support
CLOSE	PULSE_ON	Activation	May support
		Complementary latch	May support
		Complementary two-output	Preferred support
TRIP	PULSE_ON	Activation	May support
		Complementary latch	May support
		Complementary two-output	Preferred support
All other combinations		All	Not interoperable

Table A-2 indicates for a single point index, what action the outstation performs based on the contents of the interoperable control codes and the point model implemented.

Table A-2—Actions performed by outstation for interoperable commands

Row #	Control code	TCC field	Op Type field	Clear field	Action
1	0x00	NUL	NUL	0	Does not initiate an action or change an in-progress or pending command. Values in <i>On-time</i> and <i>Off-time</i> fields are ignored.
2	0x20	NUL	NUL	1	Cancel in-progress and pending commands. Values in <i>On-time</i> and <i>Off-time</i> fields are ignored.
3	0x01	NUL	PULSE_ON	0	For activation model, set output to active for the duration of the <i>On-time</i> . For both complementary models, return NOT_SUPPORTED status.

Row #	Control code	TCC field	Op Type field	Clear field	Action
4	0x21	NUL	PULSE_ON	1	For activation model, cancel in-progress and pending commands and then set output to active for the duration of the <i>On-time</i> . For both complementary models, return NOT_SUPPORTED status.
5	0x03	NUL	LATCH_ON	0	For activation model, set output to active for the duration of the <i>On-time</i> . For complementary latch model, set the output to active. For complementary two-output model, set the close output to active for the duration of the <i>On-time</i> .
6	0x23	NUL	LATCH_ON	1	Cancel in-progress and pending commands. Afterwards, initiate the action specified in row 5.
7	0x04	NUL	LATCH_OFF	0	For activation model, set output to active for the duration of the <i>On-time</i> . For complementary latch model, set the output to inactive. For complementary two-output model, set the trip output to active for the duration of the <i>On-time</i> .
8	0x24	NUL	LATCH_OFF	1	Cancel in-progress and pending commands. Afterwards, initiate the action specified in row 7.
9	0x41	CLOSE	PULSE_ON	0	For activation model, set output to active for the duration of the <i>On-time</i> . For complementary latch model, set the output to active. For complementary two-output model, set the close output to active for the duration of the <i>On-time</i> .
10	0x61	CLOSE	PULSE_ON	1	Cancel in-progress and pending commands. Afterwards, initiate the action specified in row 9.
11	0x81	TRIP	PULSE_ON	0	For activation model, set output to active for the duration of the <i>On-time</i> . For complementary latch model, set the output to inactive. For complementary two-output model, set the trip output to active for the duration of the <i>On-time</i> .
12	0xA1	TRIP	PULSE_ON	1	Cancel in-progress and pending commands. Afterwards, initiate the action specified in row 11.

DOBS is 32 bit value which is mapped to {control Code |count|OnTime|OffTim} fields.

DOBS Byte 1 = Control Code

DOBS Byte 2 = Count

DOBS Byte 3 = OnTime in Sec

DOBS Byte 4 = OffTime in Sec

In TC you need to merge 4 Bytes and make DOBS value. When Value of DOBS is changing, DNP3 Kernel will get then changes and Saves value of DOBS Tag.

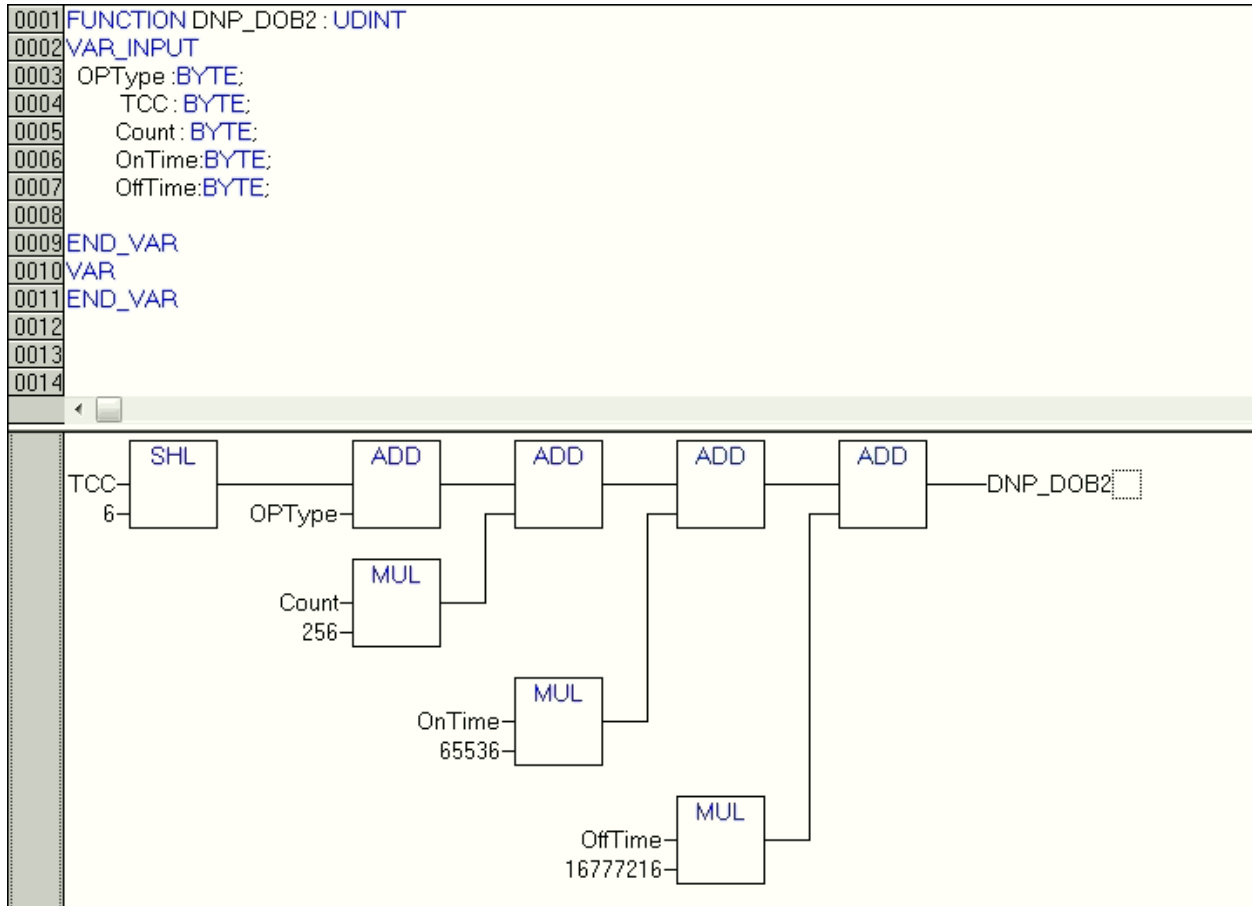
When you change DOB Tag value from 0 to 1 ,(DOB Tag that has same address as DOBS) , DNP Driver sends G12V1 With specified Flag that is saved in DOBS Tag to RTU .

If DOBS Tag is not defined for DOB Tag , Then default operation (Direct Operate or Select Before Operate) Will execute when DOB Tag Value change from 0 to 1 .

Sequence of Sending DOB Command with defined DOBS Tag:

- Set Value of DOBS Tag and Write to Kernel
- Change DOB Tag with same address of DOBS from 0 to 1.

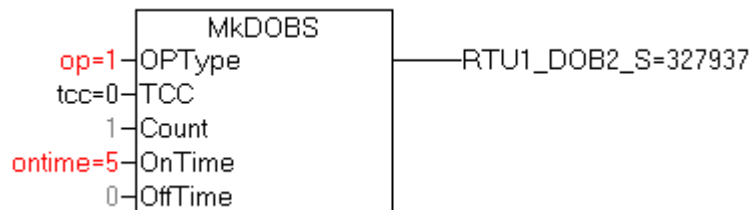
In TC with help of following function you can make DOBS tag value:



DOBS Samples :

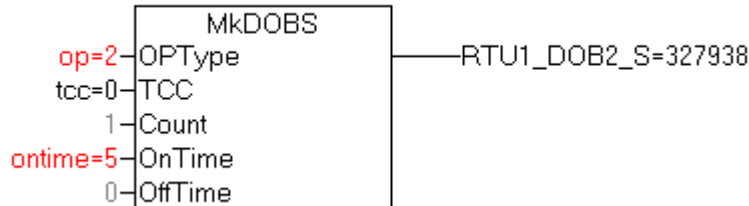
OpType = 1 (Pulse On), Count = 1 , On Time = 5 Sec , off Time = 0 , TCC = 0(Nul)

DOBS Value = 327937



OpType = 2 (Pulse Off),Count = 1 , On Time = 5 Sec , off Time = 0
, TCC = 0(Nul)

DOBS Value = 327938



OpType = 3 (Latch On),Count = 0 , On Time = 0 Sec , off Time = 0
, TCC = 0(Nul)

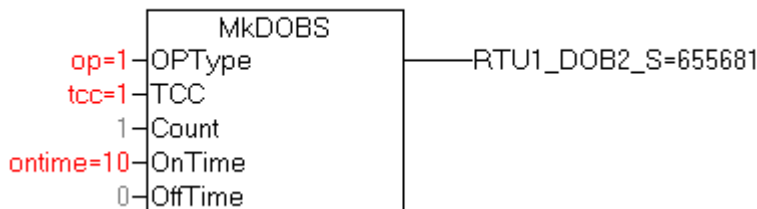
DOBS Value = 3

OpType = 4 (Latch Off),Count = 0 , On Time = 0 Sec , off Time = 0
, TCC = 0(Nul)

DOBS Value = 4

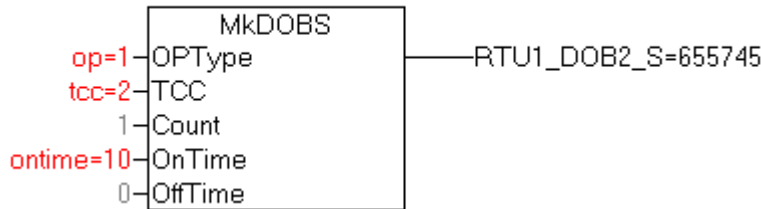
OpType = 1 (Pulse On),Count = 1 , On Time = 10 Sec , off Time = 0
, TCC = 1(Close)

DOBS Value = 655681



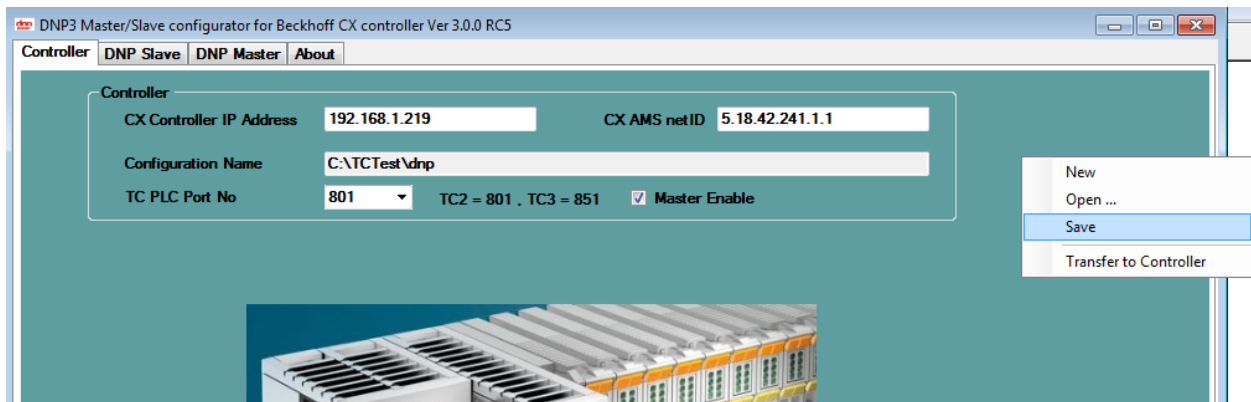
OpType = 1 (Pulse On),Count = 1 , On Time = 10 Sec , off Time = 0 , TCC = 2(Trip)

DOBS Value = 655745



Saving configuration and transfer to Controller

After setting Tag types and Address , save configuration from Controller page . Right click on Controller page and Execute Save Item .

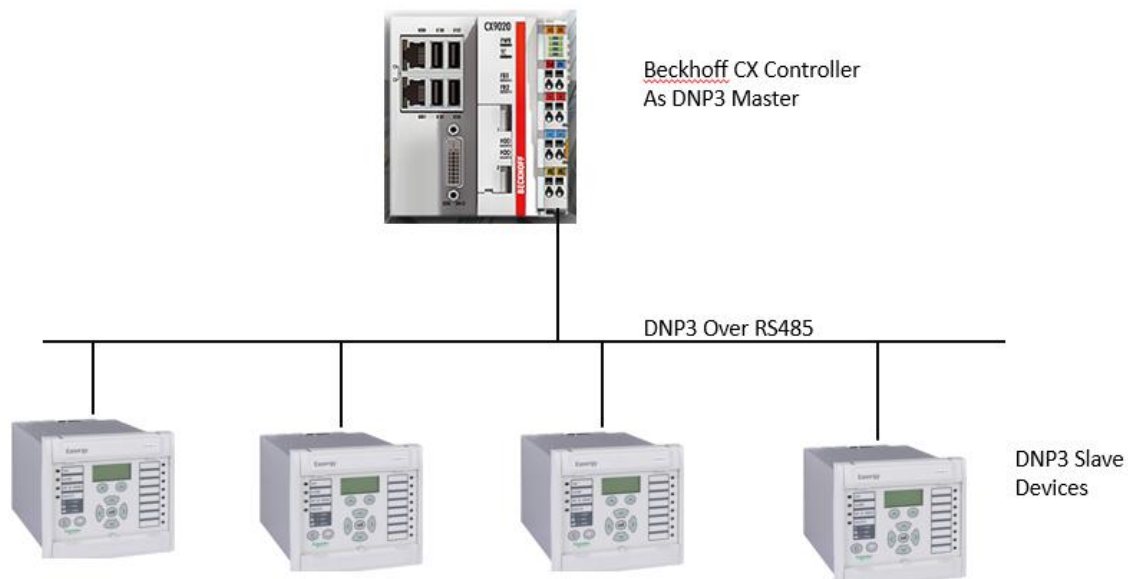


Transfer saved configuration to CX Controller by executing “Transfer to Controller” Item.

Master RS485 Gateway Mode

If you want to connect CX controller to Slave Devices like protection relays by RS485 network and using multi drop connection, then you need to enable RS485 Gateway Mode.

Suppose you want to setup following configuration:




At controller page enable Master and RS485 Gateway Mode :

Controller			
CX Controller IP Address	192.168.1.177	CX AMS netID	5.46.239.133.1.1
Configuration Name	C:\TCTest\dnpcfg2		
TC PLC Port No	801	TC2 = 801 . TC3 = 851	<input checked="" type="checkbox"/> Master Enable <input type="checkbox"/> Use UTC
	<input type="checkbox"/> Master RS485 Gateway Mode	Gateway Wait msec	1000

Add all RTUs as TCP RTU . Select an internal port Number for communication like 19000 and set RTU IP to 127.0.0.1 for all Slave RTUS.

Important Note: In Multi drop Mode Disable Unsolicited communication .

 DNP3 Master/Slave configurator for Beckhoff CX controller Ver 3.0.0 RC22

Controller DNP Slave DNP Master About							
RTUs New RTU							
RTUName	Master ID	RTUID	Physical Layer	RTUIP	TCPPort	Serial Port	Baud Rate
RTU1	1	3	TCP	127.0.0.1	19000	1	19200
RTU2	1	4	TCP	127.0.0.1	19000	1	19200
RTU3	2	5	TCP	127.0.0.1	19000	1	19200
RTU4	10	6	TCP	127.0.0.1	19000	1	19200

In driver folder you can see pbsDnp2Rs485Gw.dll

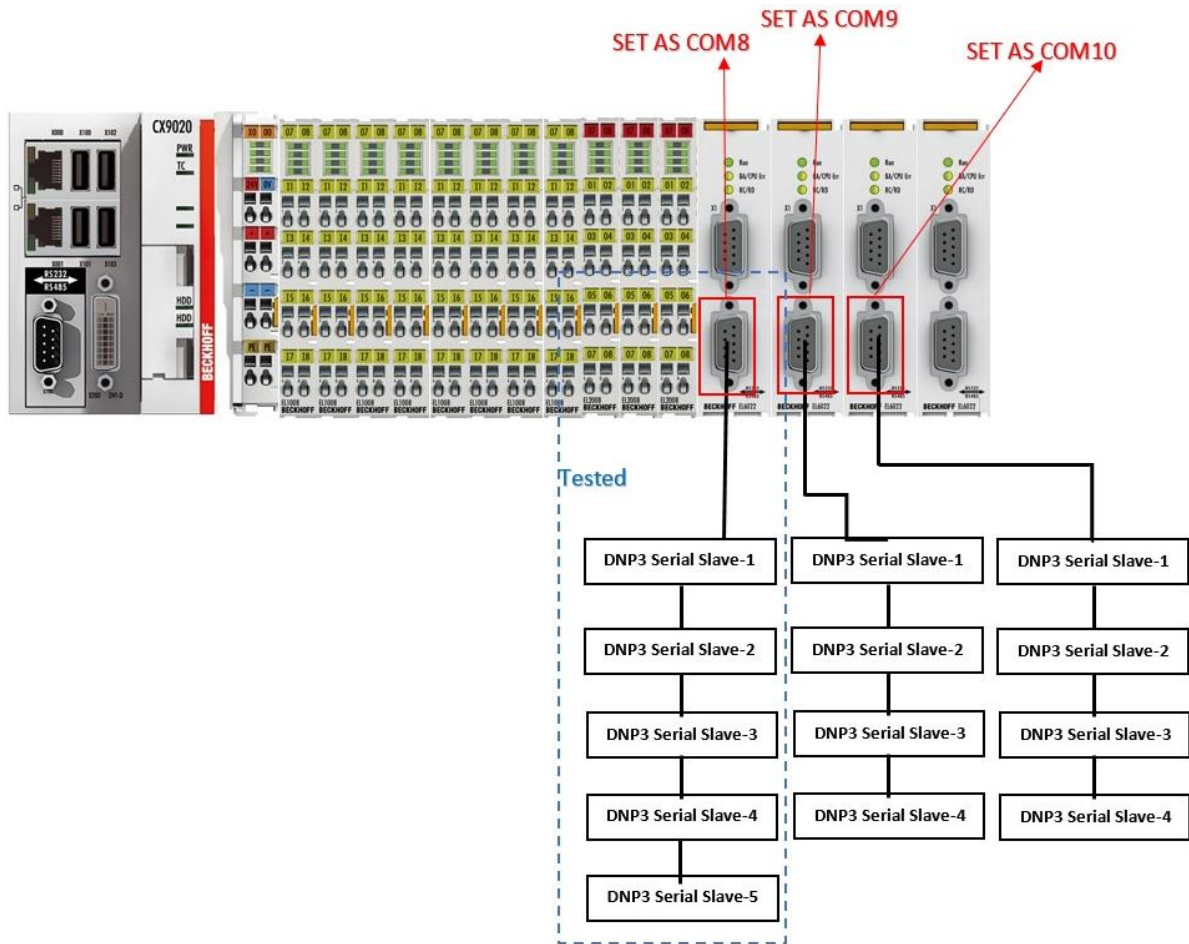
When you enable RS485 gateway Mode , above pbsDnp2Rs485Gw .dll will load automatically . This Dll is responsible for converting TCP to RS485 communication . pbsDnp2Rs485Gw is listening to Port TCPPort (you need to set same port for all Multi drop RTUs in one network like 19000 in above configuration) and all RTUS should have IP 127.0.0.1

Serial port and Baudrate should be same for all RTUS in one network . All other setting are same as TCP RTU connection .

Gateway Wait msec : because Gateway Mode is Master /Slave and every request is started by Master and Slave devices should answer to Master , so Slave device answer should not be In multi-Application fragment . Buffer size for serial communication is set to 2048 Bytes in pbsDnp2Rs485Gw.dll so your device answer should not be more than 2048 bytes for any Master request . Gateway Wait time is a time that driver is waiting for getting answer from Serial Slave Devices .

If your devices status are 31 in Master controller and not moving to 100 which is online , you need to increase Gateway Wait time .

Suppose you want to configure following system :



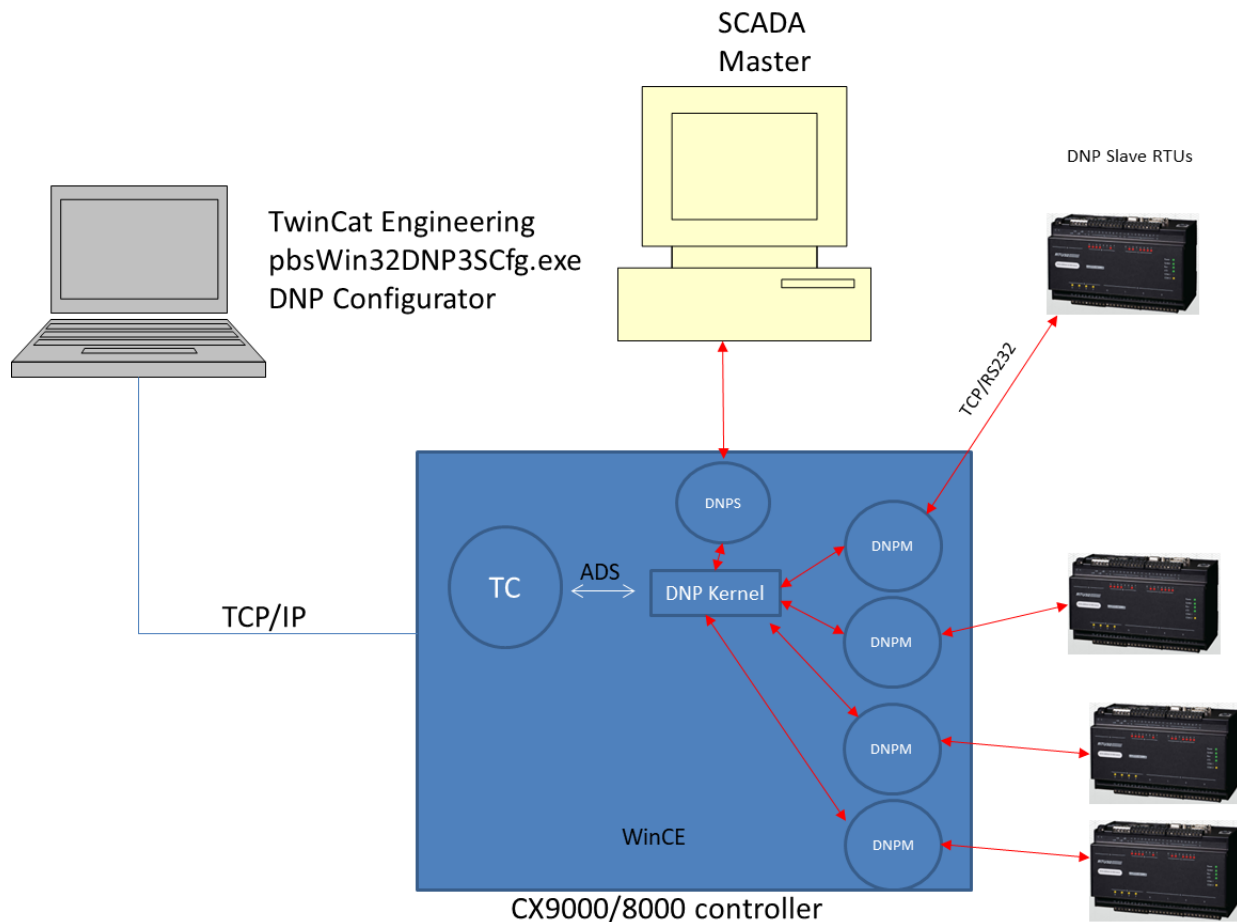
Note : all RTUS that connect to one RS485 Port , Should have same internal TCP Port for communication and all RTU should have IP 127.0.0.1

In following figure you can see configuration file for above setup . TCP port 17000 is set for COM8 , 18000 is set for COM9 and 19000 is set for COM10 .

Controller DNP Slave DNP Master About							
RTUs New RTU							
RTUName	Master ID	RTUID	Physical Layer	RTUIP	TCPPort	Serial Port	Baud Rate
▶ RTU1_8	1	3	TCP	127.0.0.1	17000	8	9600
▶ RTU2_8	1	4	TCP	127.0.0.1	17000	8	9600
▶ RTU3_8	1	5	TCP	127.0.0.1	17000	8	9600
▶ RTU4_8	1	6	TCP	127.0.0.1	17000	8	9600
▶ RTU5_8	1	7	TCP	127.0.0.1	17000	8	9600
▶ RTU1_9	1	8	TCP	127.0.0.1	18000	9	9600
▶ RTU2_9	1	9	TCP	127.0.0.1	18000	9	9600
▶ RTU3_9	1	10	TCP	127.0.0.1	18000	9	9600
▶ RTU4_9	1	11	TCP	127.0.0.1	18000	9	9600
▶ RTU1_10	1	12	TCP	127.0.0.1	19000	10	9600
▶ RTU2_10	1	13	TCP	127.0.0.1	19000	10	9600
▶ RTU3_10	1	14	TCP	127.0.0.1	19000	10	9600
▶ RTU4_10	1	15	TCP	127.0.0.1	19000	10	9600

You can define maximum 8 separate RS485 network and at each Network 10 RTU can be defined.

7 -DNP Master Operation



When DNP Kernel (pbsBecDnp3SV3.exe) is booting , it will read Configuration from dnpscfcg.xml file . DNP3 Master /Slave configuration is in dnpscfcg.xml.

DNP kernel will load DNP Master Library for each RTU that is defined in configuration . Suppose you define 4 RTU as above figure . then DNP Kernel will load 4 Separate DNP Master Library to communicate with RTUS.

If communication is RS232 , then you can link one COM port of CX to one RTU .

Name	Size	Type
dnpsi1		File Folder
RTU1		File Folder
RTU2		File Folder
dnpscfg	15.6KB	XML Document
GenMacID	5KB	Application
ITaskMgr_arm	29KB	Application
license	66 bytes	LIC File
pbsBecDNP3SV3	21KB	Application

You should have one RTUX folder in runtime folder (inside CX Controller) for each RTU . means if you define 10 DNP Slave RTU , then you should have RTU1 , RTU2,... RTU10 folder in Main DNP Folder . inside RTUX folder you should have pbsDNPMCeIX.dll library . in above figure DNP Master Library (DNPM) is equal to pbsDNPMCeIX.dll library .

DNP Kernel (pbsBecDNP3SV3.exe) is reading Input Tags from pbsDNPMCeIX.dll library and Write User commands to them .

DNP Master License has different version based on Number of DNP Slave RTUS that you want to connect to CX Controller .

DNP Master Library Sequence :

When DNP Master Library is loading to communicate with one RTU , It will do following sequence :

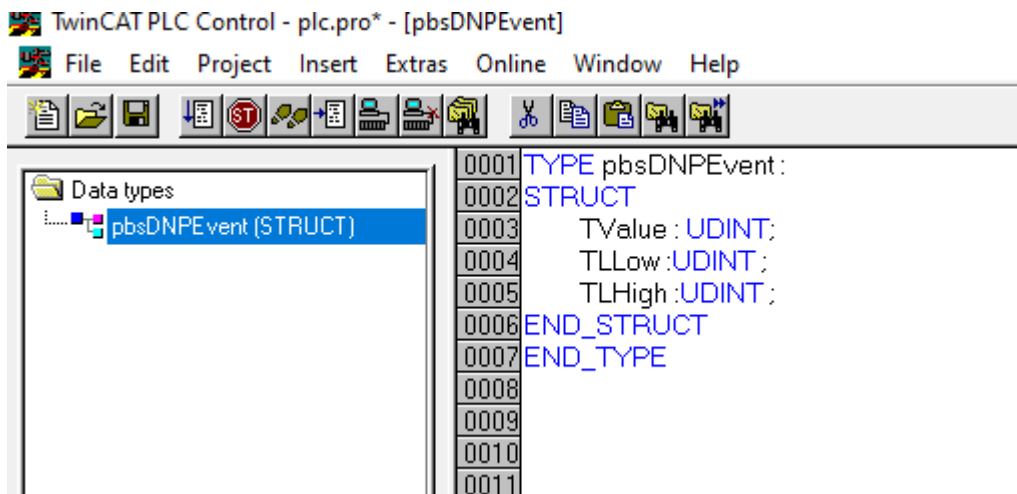
(TCP Mode)

- Try to Connect to RTU
- If connect , It will send Time Synch to RTU
- Send IP (Integrity Poll) command to RTU and read all status of Tags and buffers from RTU
- If Enable Unsolicited is enabled : Send Enable Unsolicited command to RTU
- If Enable Unsolicited is Disable : Send Disable Unsolicited command to RTU
- If UNS is Disable , Send RBE based on Configuration periodically to RTU and read Changes from RTU .
- Send IP to RTU to read all tags periodically .
- Send Time Synch Periodically.
- If there is no communication with RTU , Send Link Status to check connection status
- If communication is disconnected , Try to connect again to RTU .

8 – millisecond Digital Input Gathering from ADS

From V3 RC20 you can transfer Digital Input Buffers with msec time resolution to DNP Kernel. You need to define DIE tag type and pass Tag Value and Time label from TwinCat to DNP Kernel.

1- Define pbsDNPEvent as following :



TValue : Tag Value . 0 or 1

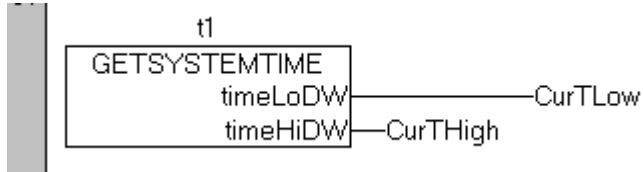
TLLow , TLLHigh : Low and High Value of Time Label .

2 – Define one Array for each DNP DI tag that you want to transfer its event to DNP Kernel by ADS. Suppose you have 3 DI Tags with DNP Address 1 , 2, and 3 then define 3 Array as following in TC :

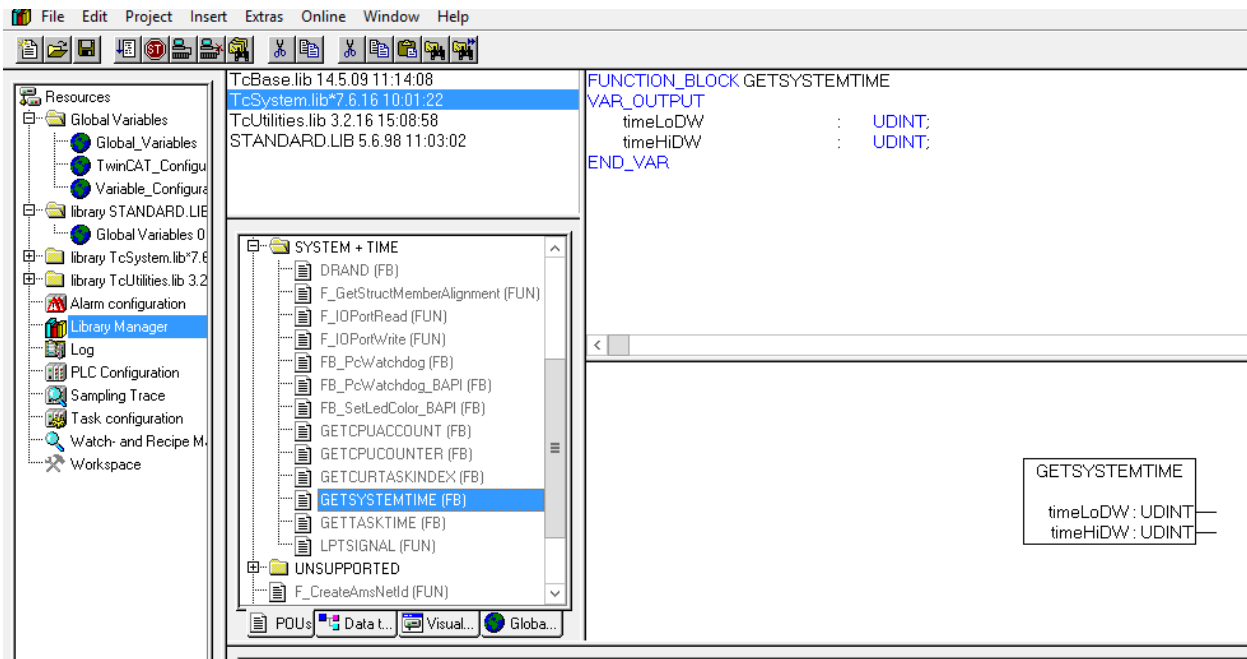
```

0164
0165 DNP3_DI1_Array      : ARRAY[0..100] OF pbsDNPEvent;
0166 DNP3_DI2_Array      : ARRAY[0..100] OF pbsDNPEvent;
0167 DNP3_DI3_Array      : ARRAY[0..100] OF pbsDNPEvent;
0168
0169
    
```


3 – Use GETSYSTEMTIME FB in TC and get current time label for your Tag and fill above Arrays.



You need to add GETSYSTEMTIME by Library Manager of TwinCat :



4 – Index 0 of Arrays is used for synchronizing between ADS and DNP Kernel. Does not use index 0 for event.

Index 0, TagValue shows number of Events in Array

Index 0, TLHigh is a Seq Number . Every time you want to transfer buffer to DNP Kernel increase it by 1. When you reach to 32000 then again set it to 0.

5 – In DNP Configurator you can see following tags :

<input checked="" type="checkbox"/>	.DNP3_DI1_ARRAY	ARRAY [0..100] OF PBSDNPEVENT	16448	1360	1212	DIE	1	1
<input checked="" type="checkbox"/>	.DNP3_DI2_ARRAY	ARRAY [0..100] OF PBSDNPEVENT	16448	140	1212	DIE	1	2
<input checked="" type="checkbox"/>	.DNP3_DI3_ARRAY	ARRAY [0..100] OF PBSDNPEVENT	16448	2572	1212	DIE	1	3

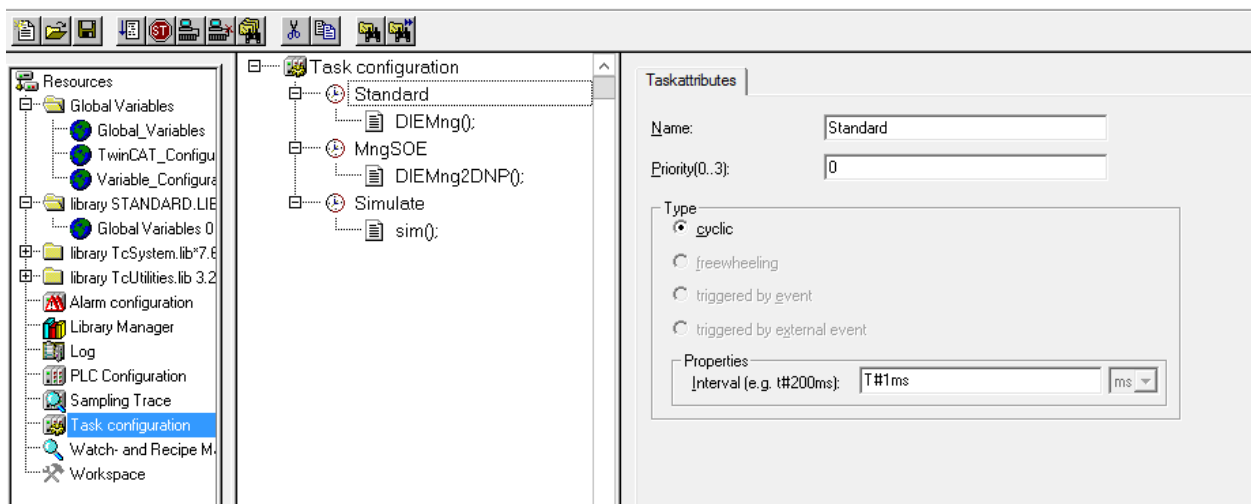
Set DNP Type for Arrays to DIE .please notice that you should Defined DI tags with DNP address 1, 2, 3, in TC and configurator.

<input checked="" type="checkbox"/>	.DNP3_DI1	BOOL	61489	1664	1	DI	1	1
<input checked="" type="checkbox"/>	.DNP3_DI10	BOOL	61489	1673	1	DI	1	10
<input checked="" type="checkbox"/>	.DNP3_DI2	BOOL	61489	1665	1	DI	1	2
<input checked="" type="checkbox"/>	.DNP3_DI3	BOOL	61489	1666	1	DI	1	3
<input checked="" type="checkbox"/>	.DNP3_DI4	BOOL	61489	1667	1	DI	1	4
<input checked="" type="checkbox"/>	.DNP3_DI5	BOOL	61489	1668	1	DI	1	5
<input checked="" type="checkbox"/>	.DNP3_DI6	BOOL	61489	1669	1	DI	1	6

Set Class and DNP Address of DIE Tags same as main DI Tags.

You can develop different TwinCat Application for filling DIE Arrays. In This section we will show you very simple TC application for this purpose.

Define two tasks in TC.



Suppose Task Names are Standard and MngSOE . Standard Task is responsible for detecting changes in DI Tags that you want to

have SOE. If you need to have 1 millisecond resolution, you need to set Task Cyclic time at least on 1 msc.

Standard Task is detecting changes in DI tags and buffer them in DIE arrays .

MngSOE Task is transferring Buffers to DNP3 Kernel .

We consider 100 buffer for each time transfer from TC to DNP Kernel . So you need to set cyclic time of MngSOE based on time resolution that you need.

Suppose one physical Digital input Signal is changing every 5 msec in pulse format . So 200 changes you have in 1 sec . Then you need to set MngSOE cyclic task to less than 500 msec ,for example 400 msec is enough.

Global Variables in TC :

Suppose we want to have SOE for 3 DI Tags . So you should define following Variables in Global Tags of TwinCAT:

```
DNP3DI1_Array : ARRAY[0..100] OF pbsDNPEvent;  
DNP3DI2_Array : ARRAY[0..100] OF pbsDNPEvent;  
DNP3DI3_Array : ARRAY[0..100] OF pbsDNPEvent;
```

```
tDNP3DI1_Array_index : UDINT := 1;  
tDNP3DI2_Array_index : UDINT := 1;  
tDNP3DI3_Array_index : UDINT := 1;
```

```
PhyDI1 : BOOL; (*Should be link TO Physical Signal*)  
PhyDI1_Old : BOOL;
```

```
PhyDI2 : BOOL; (*Should be link TO Physical Signal*)  
PhyDI2_Old : BOOL;
```

```
PhyDI3 : BOOL; (*Should be link TO Physical Signal*)  
PhyDI3_Old : BOOL;
```

DNP3DI1_Array is Buffer of Values and Time labels for DI1 Tag. Maximum 100 events can be transfer to DNP Kernel on each transfer.

tDNP3DI1_Array_index is internal tag for TC (no need to transfer to DNP Kernel) and Shows current index in DNP3DI1_Array .

PhyDI1 Variable should map to physical Digital input Tag that is gather from DI card.

PhyDI1_Old is used for detect changes of PhyDI1 Tag .

ST program for Standard Task:

```
PROGRAM DIEMng
VAR
  t1: GETSYSTEMTIME;
END_VAR

IF PhyDI1_Old <> PhyDI1 THEN
  PhyDI1_Old :=PhyDI1;
  DNP3_DI1:=PhyDI1;
  IF tDNP3DI1_Array_index<99 THEN

    IF PhyDI1=TRUE THEN
      DNP3DI1_Array[tDNP3DI1_Array_index].TValue :=1;
    ELSE
      DNP3DI1_Array[tDNP3DI1_Array_index].TValue :=0;
    END_IF
    t1();
    DNP3DI1_Array[tDNP3DI1_Array_index].TLLOW :=t1.timeLoDW;
    DNP3DI1_Array[tDNP3DI1_Array_index].TLHigh :=t1.timeHiDW;
    tDNP3DI1_Array_index:=tDNP3DI1_Array_index+1;
  END_IF
END_IF
```

For each DI tags, you should have above code .At each cycle of Standard Task, changes of Digital input Tags is detect. If it is changed, current time is get from Controller and Value of DI Tag and time is placed in DIE array and Array Index is increase by one.

Please notice that you need to update both DI and DIE tags , DI is used only for class 0 and DIE is used for class1/2/3

ST program for MngSOE Task:

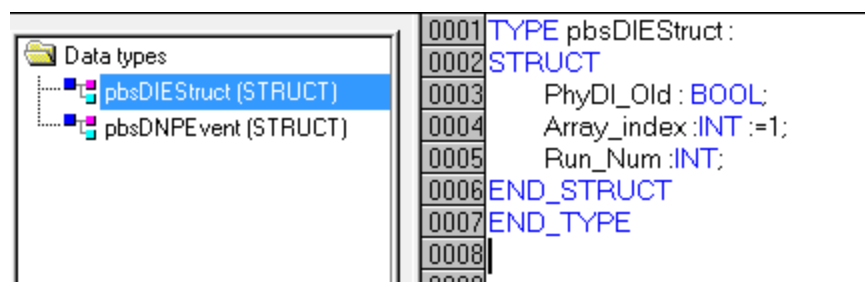
```
1 PROGRAM DIEMng2DNP
2 VAR
3 END_VAR
4
5
6
7
8
9
10
11 IF tDNP3DI1_Array_index > 1 THEN
12     DNP3DI1_Array[0].TValue := tDNP3DI1_Array_index;
13     DNP3DI1_Array[0].TLHigh := DNP3DI1_Array[0].TLHigh + 1;
14     tDNP3DI1_Array_index := 1;
15
16 ELSE
17
18     IF DNP3DI1_Array[0].TLHigh > 32000 THEN
19         DNP3DI1_Array[0].TLHigh := 0;
20     END_IF
21 END_IF
```

Again for each DIE tag you need to develop above code for Transferring Buffer to DNP Kernel.

If Array Index is bigger than 1 , Index 0 of array will fill by proper values and array Index is reset to 1 . Please notice that Index 0 is used by DNP Kernel and you should always use from index 1 for buffering.

You can define specific Function Block to make mse transfer to DNP Kernel easier:

Define pbsDIEStruct as following:



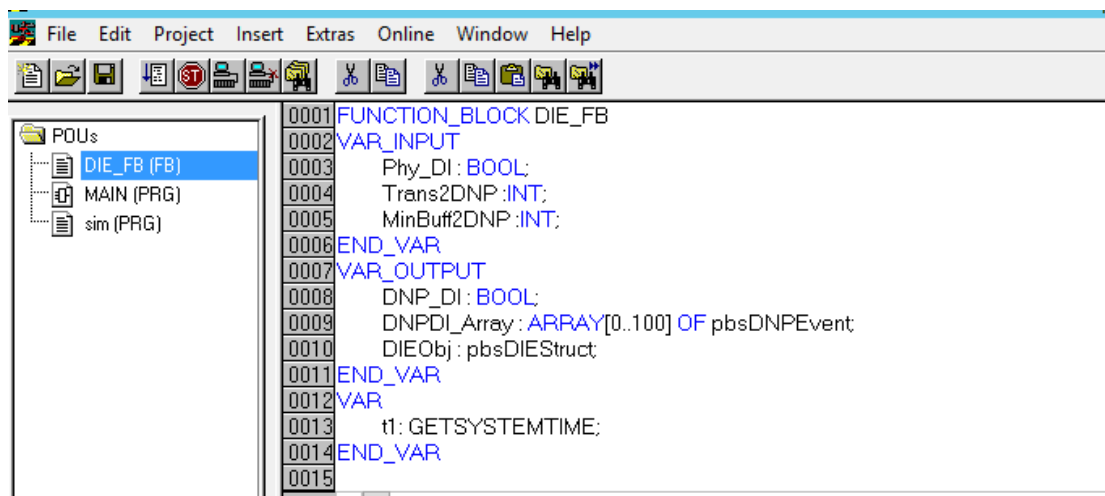
```
0001 TYPE pbsDIEStruct :
0002 STRUCT
0003     PhyDI_Old : BOOL;
0004     Array_index : INT := 1;
0005     Run_Num : INT;
0006 END_STRUCT
0007 END_TYPE
0008
0009
```

Define Following global tags, suppose you want to Manage DIE for 10 DI tags:

```

0001 VAR_GLOBAL
0002
0003     DNP3_DI1 AT %Q* : BOOL;
0004     DNP3_DI2 AT %Q* : BOOL;
0005     DNP3_DI3 AT %Q* : BOOL;
0006     DNP3_DI4 AT %Q* : BOOL;
0007     DNP3_DI5 AT %Q* : BOOL;
0008     DNP3_DI6 AT %Q* : BOOL;
0009     DNP3_DI7 AT %Q* : BOOL;
0010     DNP3_DI8 AT %Q* : BOOL;
0011     DNP3_DI9 AT %Q* : BOOL;
0012     DNP3_DI10 AT %Q* : BOOL;
0013
0014     DNP3DI1_Array : ARRAY[0..100] OF pbsDNPEvent;
0015     DNP3DI2_Array : ARRAY[0..100] OF pbsDNPEvent;
0016     DNP3DI3_Array : ARRAY[0..100] OF pbsDNPEvent;
0017     DNP3DI4_Array : ARRAY[0..100] OF pbsDNPEvent;
0018     DNP3DI5_Array : ARRAY[0..100] OF pbsDNPEvent;
0019     DNP3DI6_Array : ARRAY[0..100] OF pbsDNPEvent;
0020     DNP3DI7_Array : ARRAY[0..100] OF pbsDNPEvent;
0021     DNP3DI8_Array : ARRAY[0..100] OF pbsDNPEvent;
0022     DNP3DI9_Array : ARRAY[0..100] OF pbsDNPEvent;
0023     DNP3DI10_Array : ARRAY[0..100] OF pbsDNPEvent;
0024
0025     DIE_Array : ARRAY[0..10] OF pbsDIEStruct;
0026
0027     PhyDISimu : ARRAY[0..10] OF BOOL;
0028 END_VAR
    
```

Define DIE_FB as following:



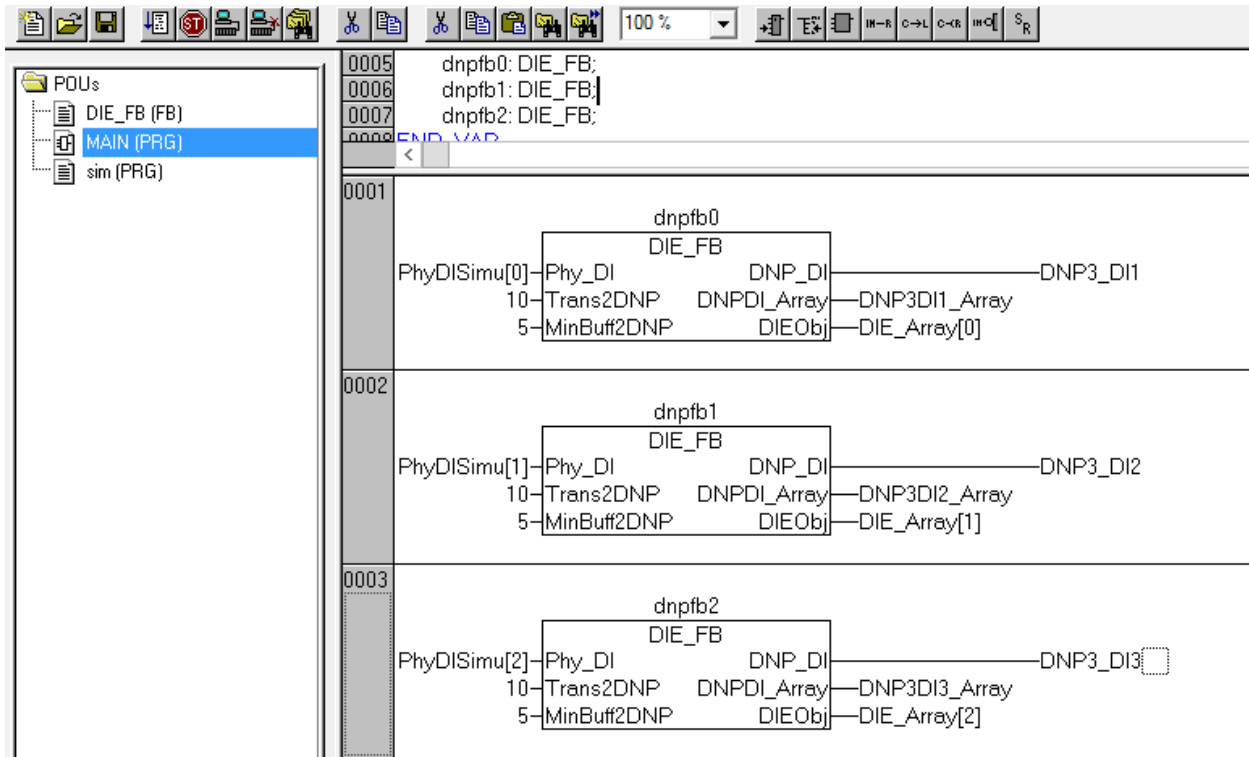
```

0001 FUNCTION_BLOCK DIE_FB
0002 VAR_INPUT
0003     Phy_DI : BOOL;
0004     Trans2DNP : INT;
0005     MinBuff2DNP : INT;
0006 END_VAR
0007
0008
0009
0010
0011
0012
0013
0014
0015
0016
0017
0018
0019
0020
0021
0022
0023
0024
0025
0026
0027
0028
0029
0030

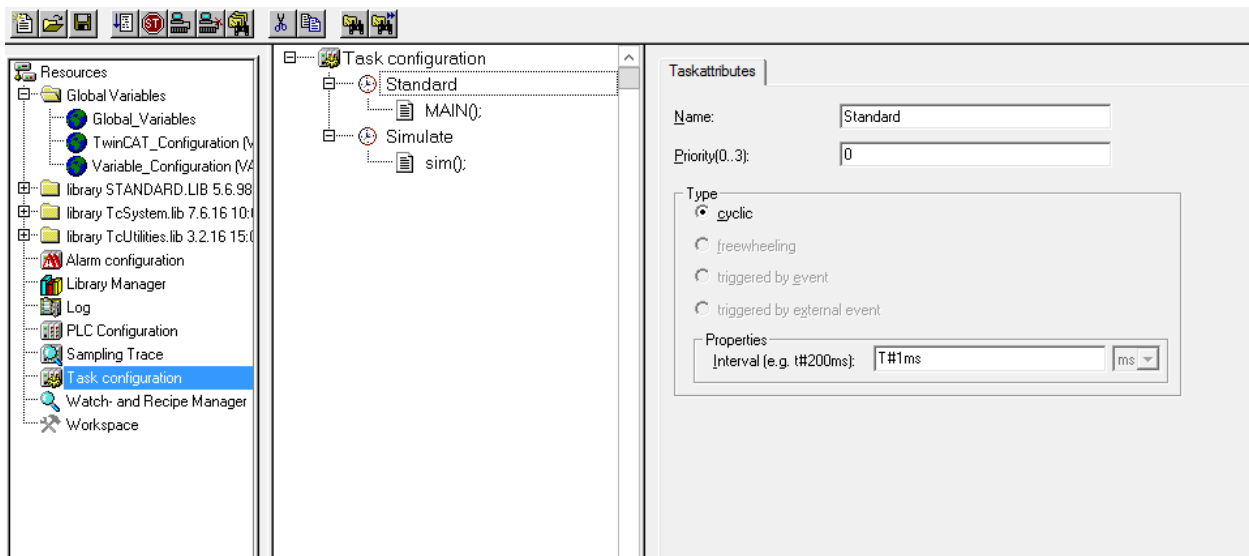
```

0001 DNP_DI := Phy_DI;
0002 IF DIEObj.PhyDI_Old <> Phy_DI THEN
0003 DIEObj.PhyDI_Old := Phy_DI;
0004 IF DIEObj.Array_index < 99 THEN
0005 IF Phy_DI = TRUE THEN
0006 DNPDI_Array[DIEObj.Array_index].TValue := 1;
0007
0008 ELSE
0009 DNPDI_Array[DIEObj.Array_index].TValue := 0;
0010 END_IF;
0011 t1();
0012 DNPDI_Array[DIEObj.Array_index].TLHigh := t1.timeHiDW;
0013 DNPDI_Array[DIEObj.Array_index].TLLOW := t1.timeLoDW;
0014 DIEObj.Array_index := DIEObj.Array_index + 1;
0015 END_IF;
0016 END_IF;
0017 IF DIEObj.Run_Num > Trans2DNP THEN
0018 DIEObj.Run_Num := 0;
0019 IF DIEObj.Array_index > MinBuff2DNP THEN
0020 DNPDI_Array[0].TValue := DIEObj.Array_index;
0021 DNPDI_Array[0].TLHigh := DNPDI_Array[0].TLHigh + 1;
0022 DIEObj.Array_index := 1;
0023 ELSE
0024 IF DNPDI_Array[0].TLHigh > 32000 THEN
0025 DNPDI_Array[0].TLHigh := 0;
0026 END_IF
0027 END_IF;
0028 END_IF;
0029 DIEObj.Run_Num := DIEObj.Run_Num + 1;
0030

Define one FBD program and put 10 DIE_FB Function Block and link tags as following :



Define 1 mses Task and link above FBD to task:



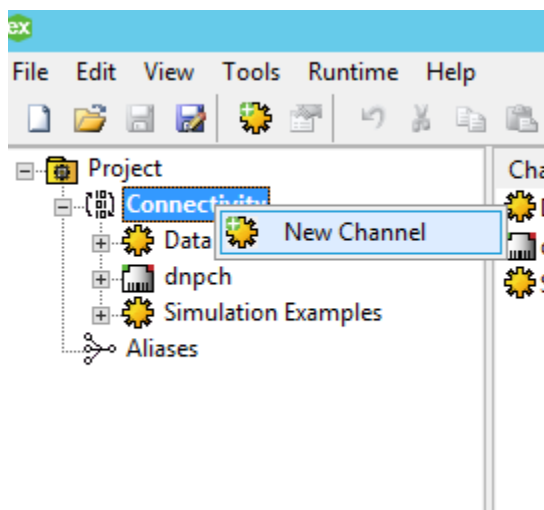
9 – KepwareEX DNP Connection Guide

In this part, we will see how to connect Beckhoff RTU as DNP Slave to KepwareEX over TCP connection.

The Kepware Server version that is used is V6.4.321, but DNP connection concepts are the same for the older version.

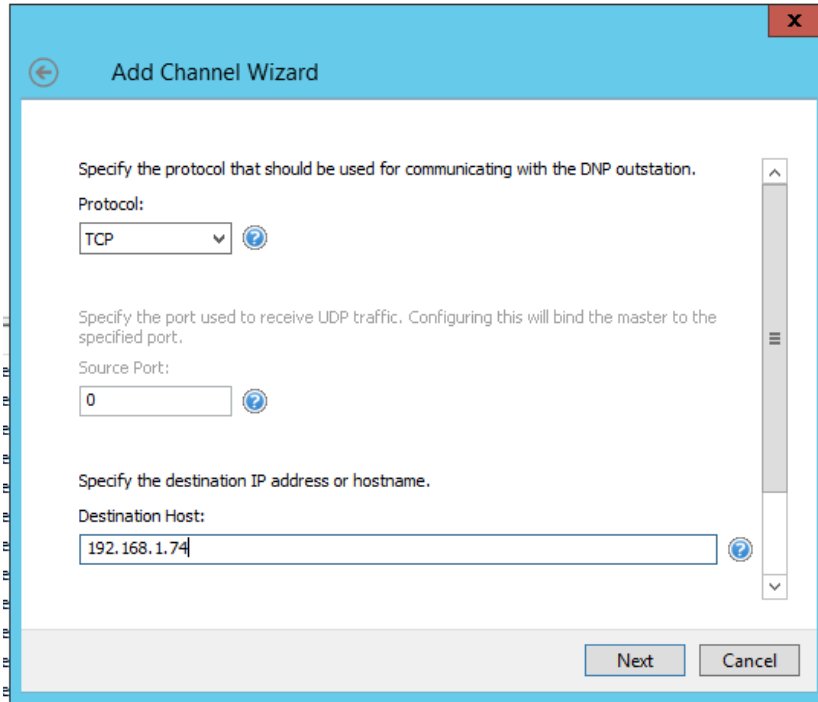
First of all, there is a Beckhoff ADS driver in KepwareEX that is used for communication with Beckhoff Systems based on Beckhoff ADS protocol. We are not talking about this driver and if you configure this driver, the DNP Configurator couldn't read tags from RTU.

- 1- In KepwareEX Configurator , Right Click on Connectivity object and add new channel .



- 2 – From Driver List Select “DNP Master Ethernet”. If it is not installed , you need to install DNP driver package on Kepware Server .

3 – Select default parameters of channel and set destination host IP address equal to beckhoff RTU IP address.



4 - At end, you can see channel parameters like following page:

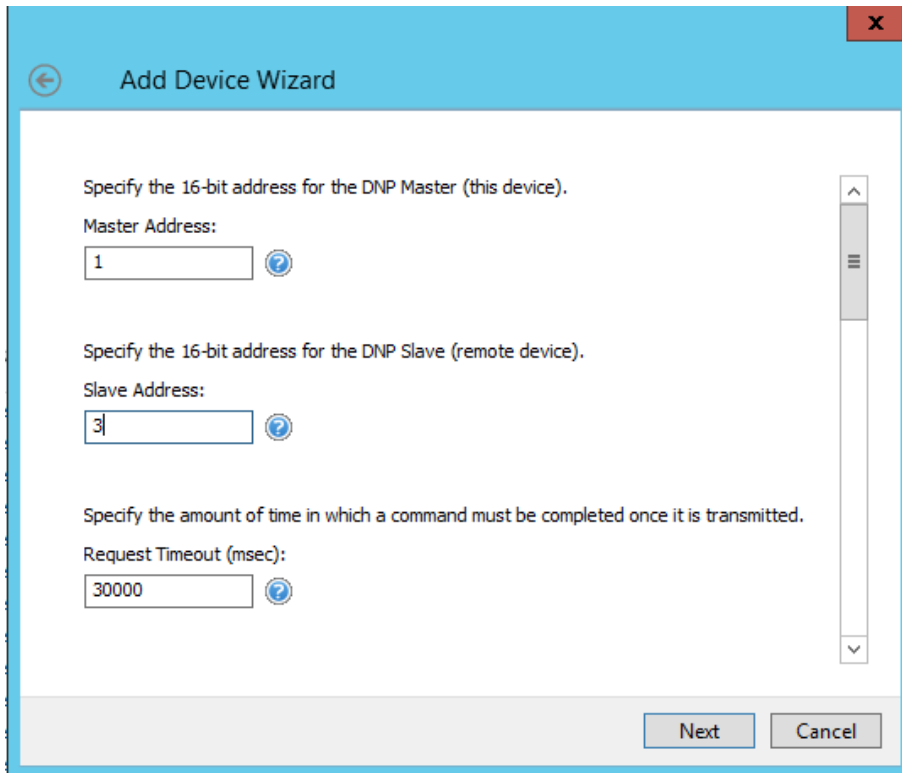
The screenshot shows a software window titled "Add Channel Wizard" with a close button (X) in the top right corner. The window contains a list of configuration categories, each with a collapse/expand icon (minus/plus sign) on the left. The categories and their values are as follows:

Identification	
Name	dnpch2
Description	
Driver	DNP Master Ethernet
Diagnostics	
Diagnostics Capture	Disable
Ethernet Settings	
Network Adapter	Default
Write Optimizations	
Optimization Method	Write Only Latest Value for All Tags
Duty Cycle	10
Non-Normalized Float Handling	
Floating-Point Values	Unmodified
Channel-Level Settings	
Virtual Network	None
Transactions per Cycle	1
Global Settings	
Network Mode	Load Balanced
Communications	
Protocol	TCP
Source Port	0
Destination Host	192.168.1.74
Destination Port	20000
Timing	
Connect Timeout (s)	3
Response Timeout (ms)	10000
Max Link Layer Retries	3

At the bottom of the dialog, there is a "Destination Port" section with the text "Specify the destination port." and two buttons: "Finish" and "Cancel".

If you use different TCP port for DNP you need to set in Destination Port field. Click on Finish to add DNP channel to configuration.

5 – In this Stage, Add a device to channel. Set device name and use default parameters until you reach to set DNP Address page:



Specify the 16-bit address for the DNP Master (this device).

Master Address:

Specify the 16-bit address for the DNP Slave (remote device).

Slave Address:

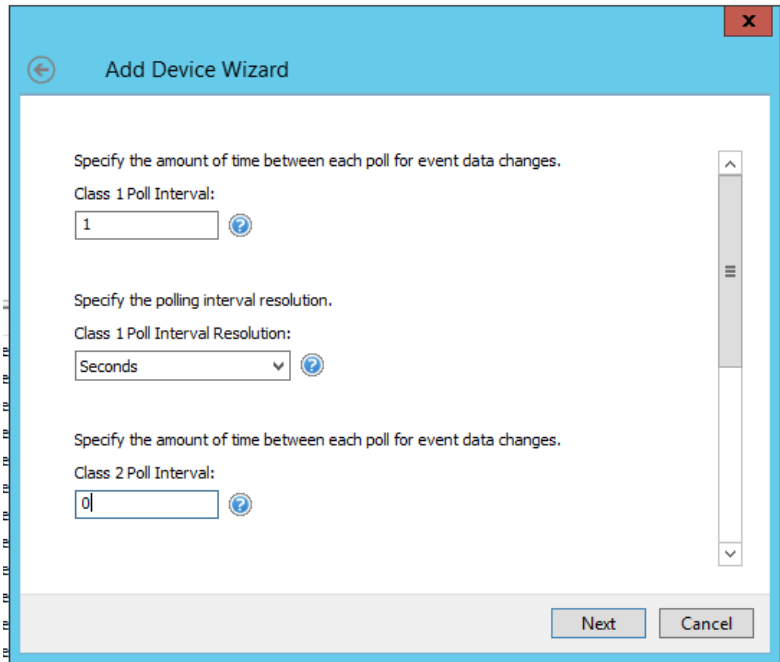
Specify the amount of time in which a command must be completed once it is transmitted.

Request Timeout (msec):

Next Cancel

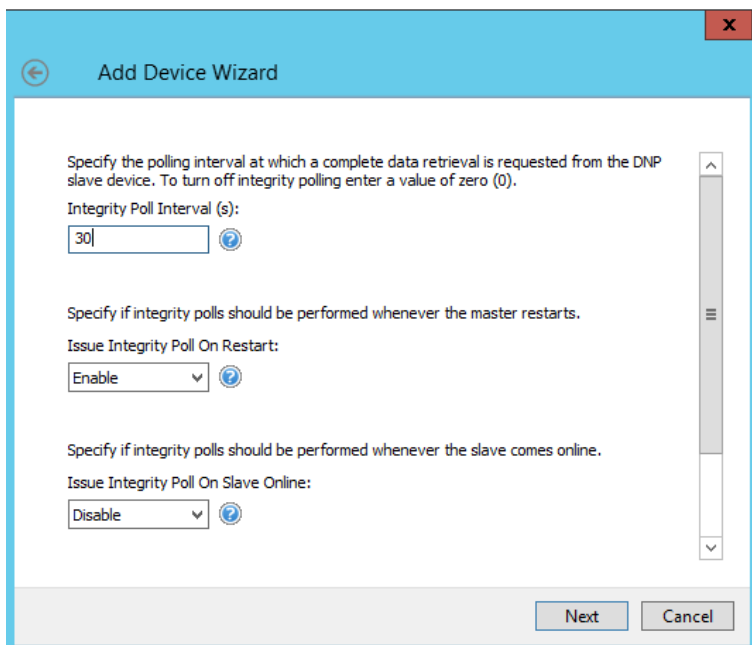
Set Master and RTU Address same values that you set before in Beckhoff DNP Configurator .

6 – In next page, you need to set how Kepware is reading data from RTU . You can read data by sending periodic class read request, like following page:

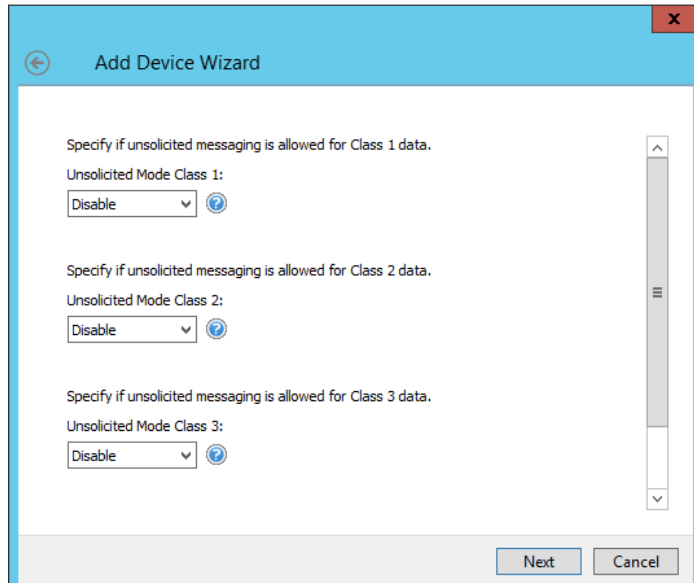


In Above setting Kepware is reading event changes every second and not sending any request for class 2 and 3.

7 – In next page you need to set how to send integrity poll to RTU.



8 – In next page you need to set unsolicited communication.



For proper communication with RTU , master should send class data request and IP periodically or enable unsolicited (to send changes by RTU) and send IP periodically .

For our test , we disable unsolicited communication and just read class1 every sec and send IP every 30 sec .

9 – Use default parameters for other pages until you reach to setting command parameters page, In this page you can set

Direct Operate or Select before Operate . Always disable

Specify whether the writable I/O points use the Direct Operate or Select then Operate sequence.

Operate Mode:
Direct Operate

Specify if a feedback poll should occur after an operate.

Feedback Poll After Operate:
Disable

Specify if timestamp tags should display time in local time instead of UTC time.

Timestamp To Local Time:
Disable

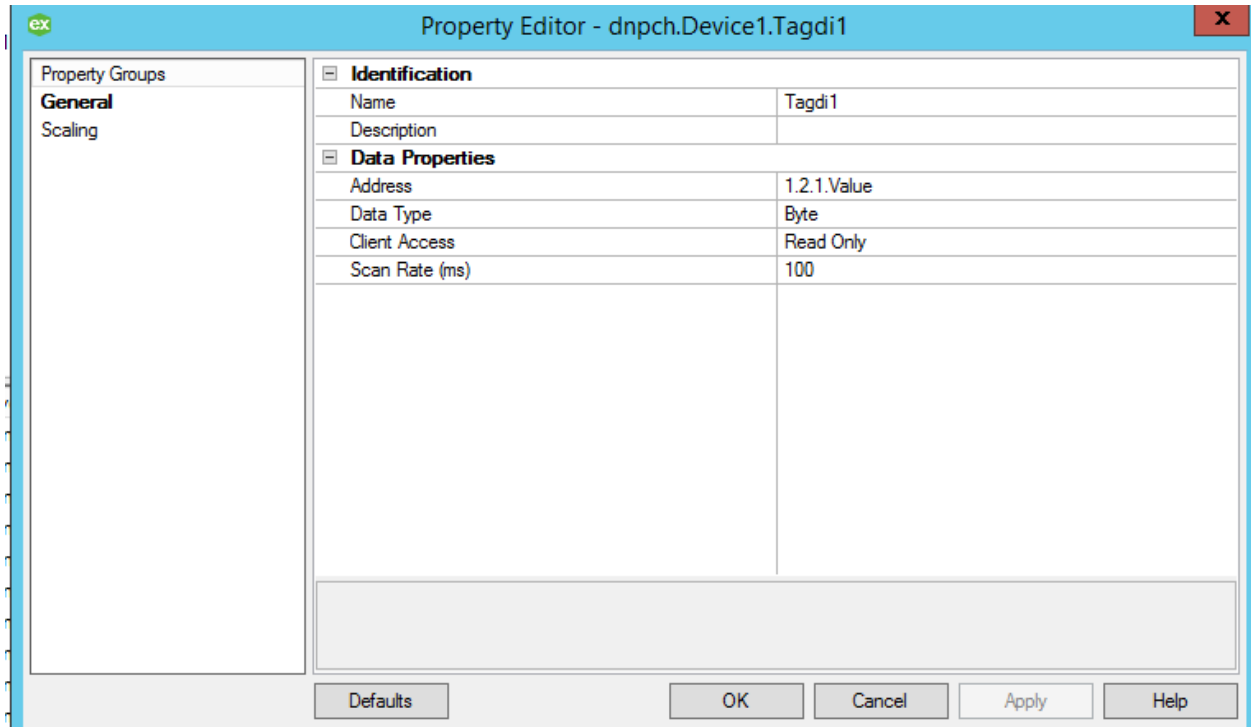
Next Cancel

“Feedback poll after operate “.

In this page you can set time based in RTU and Master, is it Local or UTC? You need to set same parameters for Master and RTU.

10 – In next page you can see all parameters. Click on Finished to add device to channel.

11 – In this stage you should add DNP tags to device. Right Click on device and add new tag. You will see following page:



For setting Address you should use following format:

Groupcode.Variation.Address.Value

For adding DI tag use address as following as an example :

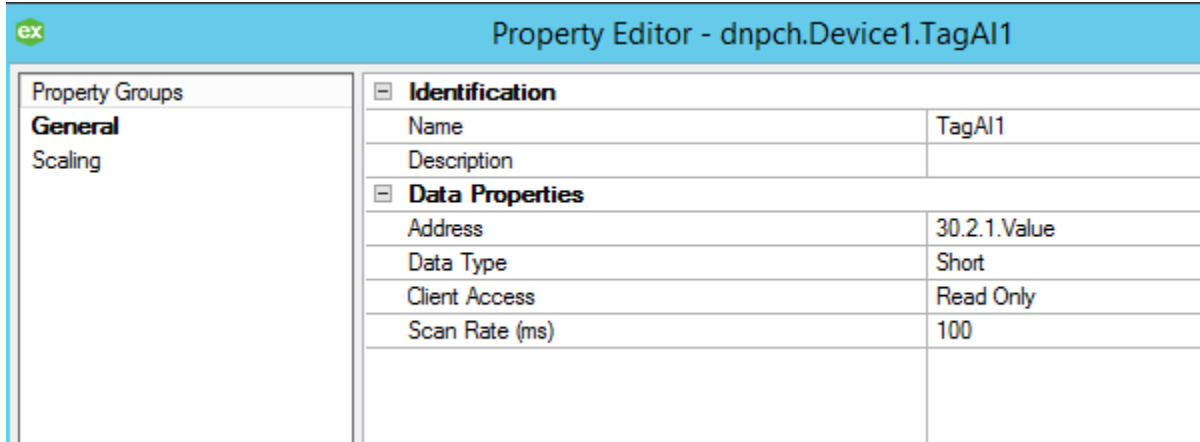
1.2.1.value

1 = DNP Group code

2 = Variation , read by flag

1 = DNP Tag Address

For adding AI tag with DNP address 1 use following setting:



The screenshot shows the 'Property Editor' window for 'dnpch.Device1.TagAI1'. The left sidebar shows 'Property Groups' with 'General' selected. The main area displays the following properties:

Identification	
Name	TagAI1
Description	
Data Properties	
Address	30.2.1.Value
Data Type	Short
Client Access	Read Only
Scan Rate (ms)	100

Address Format :

30.2.1.Value

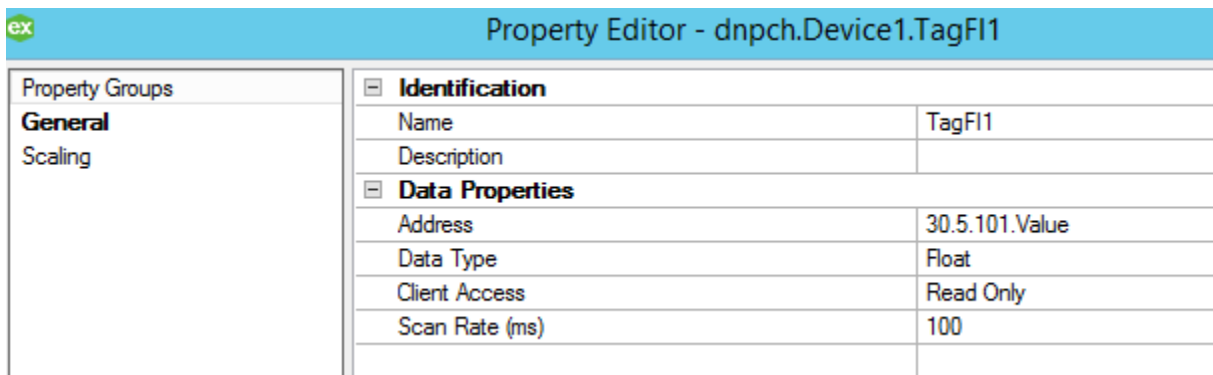
30 = DNP Analog Group

2 = 16 bit variation

1 = DNP Tag Address

Set Data Type on Short and Client access on Read Only.

For reading FI tag from RTU with address 101 use following setting:



The screenshot shows the 'Property Editor' window for 'dnpch.Device1.TagFI1'. The left sidebar shows 'Property Groups' with 'General' selected. The main area displays the following properties:

Identification	
Name	TagFI1
Description	
Data Properties	
Address	30.5.101.Value
Data Type	Float
Client Access	Read Only
Scan Rate (ms)	100

Address Format:

30 = DNP Analog Group

5 = float variation

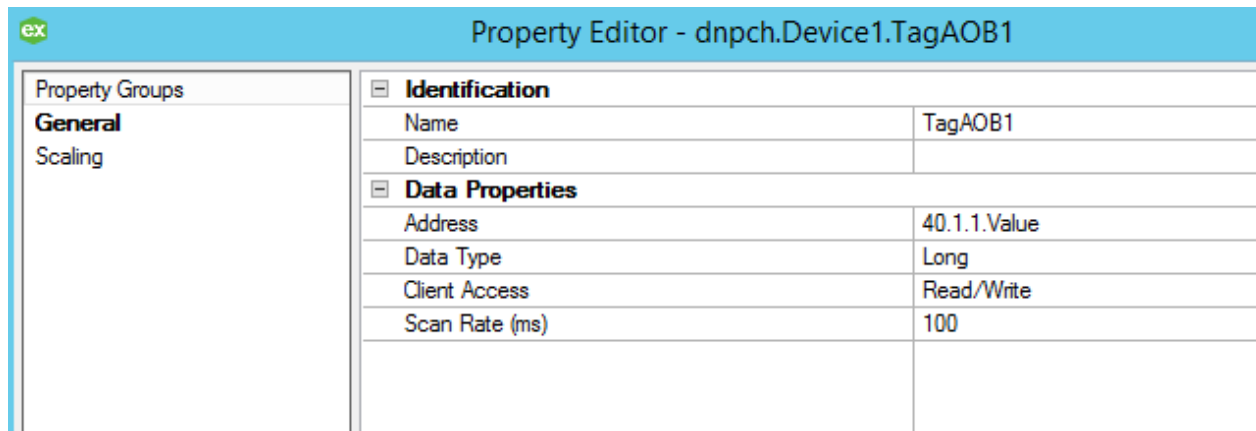
101 = DNP tag address

Data Type = Float

Client Access = Read Only

For Defining DOB , AOB and FOB tags you should define DO , AO and FO tags with same address of DOB , AOB and FOB in RTU , otherwise in Kepware AOB and DOB tag quality is BAD.

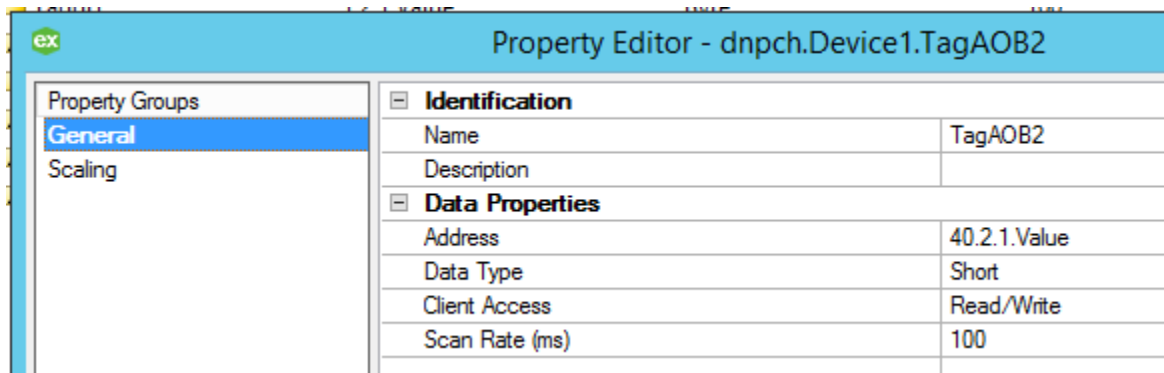
For defining AOB in Kepware you need to use Group 40 :



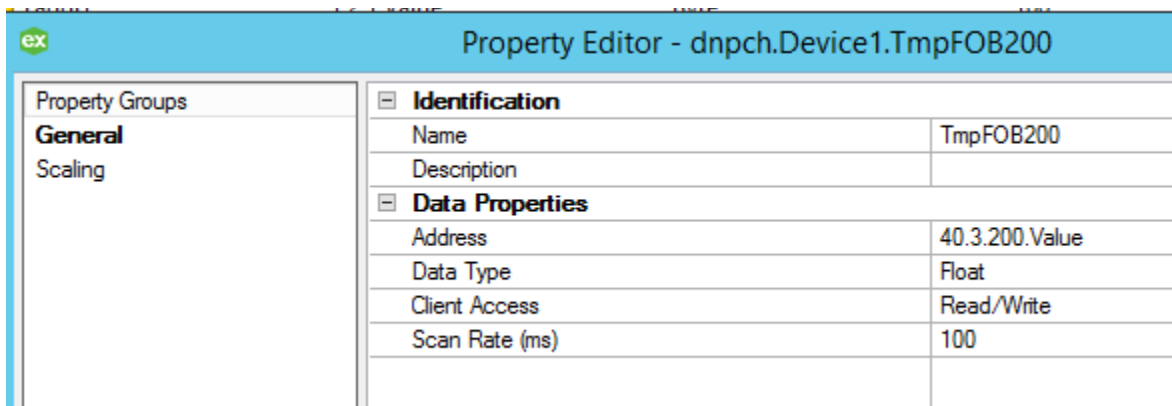
Variation 1 is 32 bit Written (Long) and variation 2 is 16 Bit (Short) Written and variation 3 is Floating Point Written.

For Written as Floating Point you should define FOB tag in RTU.

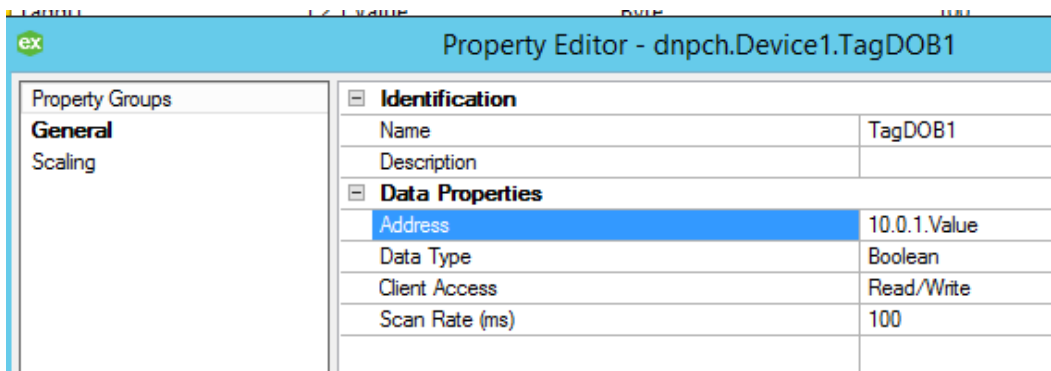
For writing as short value to RTU you should use variation 2:



For writing as float , use variation 3 :



For DOB you need to use Group 10 variation 0. from Kepware documentation : “To perform digital control operations (such as electro-mechanical relays) at binary output points using object group 12, variation 1, use tags addressed with object group 10. An operation on an object group 10 tag issues the CROB command using object group 12, variation 1.”



Look at following tags that is defined in TwinCat :

DNP3_D01 AT %Q* : BOOL;
 DNP3_D02 AT %Q* : BOOL;
 DNP3_D03 AT %Q* : BOOL;
 DNP3_D04 AT %Q* : BOOL;
 DNP3_D05 AT %Q* : BOOL;
 DNP3_D06 AT %Q* : BOOL;

DNP3_A01 AT %Q* : DINT;
 DNP3_A02 AT %Q* : DINT;
 DNP3_A03 AT %Q* : DINT;
 DNP3_A04 AT %Q* : DINT;
 DNP3_A05 AT %Q* : DINT;
 DNP3_A06 AT %Q* : DINT;

DNP3_D0B1 AT %I* : BOOL;
 DNP3_D0B2 AT %I* : BOOL;
 DNP3_D0B3 AT %I* : BOOL;
 DNP3_D0B4 AT %I* : BOOL;
 DNP3_D0B5 AT %I* : BOOL;
 DNP3_D0B6 AT %I* : BOOL;

DNP3_A0B1 AT %I* : DINT;
 DNP3_A0B2 AT %I* : DINT;
 DNP3_A0B3 AT %I* : DINT;
 DNP3_A0B4 AT %I* : DINT;
 DNP3_A0B5 AT %I* : DINT;
 DNP3_A0B6 AT %I* : DINT;

AOB Definition in DNP Configurator :

Active	Tag Name	Tag Comment	Type	Group	Group Offset	GroupLen	DNPType	DNPClass	DNPAddress
<input checked="" type="checkbox"/>	.DNP3_AOB1		DINT	61472	0	4	AOB	1	1
<input checked="" type="checkbox"/>	.DNP3_AOB10		DINT	61472	36	4	AOB	1	10
<input checked="" type="checkbox"/>	.DNP3_AOB2		DINT	61472	4	4	AOB	1	2
<input checked="" type="checkbox"/>	.DNP3_AOB3		DINT	61472	8	4	AOB	1	3
<input checked="" type="checkbox"/>	.DNP3_AOB4		DINT	61472	12	4	AOB	1	4
<input checked="" type="checkbox"/>	.DNP3_AOB5		DINT	61472	16	4	AOB	1	5
<input checked="" type="checkbox"/>	.DNP3_AOB6		DINT	61472	20	4	AOB	1	6
<input checked="" type="checkbox"/>	.DNP3_AOB7		DINT	61472	24	4	AOB	1	7
<input checked="" type="checkbox"/>	.DNP3_AOB8		DINT	61472	28	4	AOB	1	8
<input checked="" type="checkbox"/>	.DNP3_AOB9		DINT	61472	32	4	AOB	1	9

AO definition in DNP Configurator :

<input checked="" type="checkbox"/>	.DNP3_AO1		DINT	61488	252	4	AO	1	1
<input checked="" type="checkbox"/>	.DNP3_AO2		DINT	61488	256	4	AO	1	2
<input checked="" type="checkbox"/>	.DNP3_AO3		DINT	61488	260	4	AO	1	3
<input checked="" type="checkbox"/>	.DNP3_AO4		DINT	61488	264	4	AO	1	4
<input checked="" type="checkbox"/>	.DNP3_AO5		DINT	61488	268	4	AO	1	5
<input checked="" type="checkbox"/>	.DNP3_AO6		DINT	61488	272	4	AO	1	6

DOB Definition in DNP Configurator :

Active	Tag Name	Tag Comment	Type	Group	Group Offset	GroupLen	DNPType	DNPClass	DNPAddress
<input checked="" type="checkbox"/>	.DNP3_DOB1		BOOL	61473	320	1	DOB	1	1
<input checked="" type="checkbox"/>	.DNP3_DOB10		BOOL	61473	329	1	DOB	1	10
<input checked="" type="checkbox"/>	.DNP3_DOB2		BOOL	61473	321	1	DOB	1	2
<input checked="" type="checkbox"/>	.DNP3_DOB3		BOOL	61473	322	1	DOB	1	3
<input checked="" type="checkbox"/>	.DNP3_DOB4		BOOL	61473	323	1	DOB	1	4
<input checked="" type="checkbox"/>	.DNP3_DOB5		BOOL	61473	324	1	DOB	1	5
<input checked="" type="checkbox"/>	.DNP3_DOB6		BOOL	61473	325	1	DOB	1	6
<input checked="" type="checkbox"/>	.DNP3_DOB7		BOOL	61473	326	1	DOB	1	7
<input checked="" type="checkbox"/>	.DNP3_DOB8		BOOL	61473	327	1	DOB	1	8
<input checked="" type="checkbox"/>	.DNP3_DOB9		BOOL	61473	328	1	DOB	1	9

DO definition in DNP Configurator :

<input checked="" type="checkbox"/>	.DNP3_DO1		BOOL	61489	2208	1	DO	1	1
<input checked="" type="checkbox"/>	.DNP3_DO2		BOOL	61489	2209	1	DO	1	2
<input checked="" type="checkbox"/>	.DNP3_DO3		BOOL	61489	2210	1	DO	1	3
<input checked="" type="checkbox"/>	.DNP3_DO4		BOOL	61489	2211	1	DO	1	4
<input checked="" type="checkbox"/>	.DNP3_DO5		BOOL	61489	2212	1	DO	1	5
<input checked="" type="checkbox"/>	.DNP3_DO6		BOOL	61489	2213	1	DO	1	6

Please notice that in TwinCAT you should map DOB value to DO and AOB to AO as following sample :

```

0089
0090 DNP3_DO1 :=DNP3_DOB1;
0091 DNP3_DO2 :=DNP3_DOB2;
0092 DNP3_DO3 :=DNP3_DOB3;
0093 DNP3_DO4 :=DNP3_DOB4;
0094 DNP3_DO5 :=DNP3_DOB5;
0095
0096
0097 DNP3_AO1 :=DNP3_AOB1;
0098 DNP3_AO2 :=DNP3_AOB2;
0099 DNP3_AO3 :=DNP3_AOB3;
0100 DNP3_AO4 :=DNP3_AOB4;
0101 DNP3_AO5 :=DNP3_AOB5;
0102

```

For FOB and FO you need to define tags as following sample in TwinCAT :

```

DNP3_FOB1 AT %I* : REAL;
DNP3_FOB2 AT %I* : REAL;
DNP3_FOB3 AT %I* : REAL;

```

```

DNP3_FO1 AT %Q* : REAL;
DNP3_FO2 AT %Q* : REAL;
DNP3_FO3 AT %Q* : REAL;
DNP3_FO4 AT %Q* : REAL;
DNP3_FO5 AT %Q* : REAL;

```

And in configurator you need define tags as FOB and FO as following sample:

<input checked="" type="checkbox"/>	.DNP3_FO1	REAL	61488	280	4	FO	1	200
<input checked="" type="checkbox"/>	.DNP3_FO2	REAL	61488	284	4	FO	1	201
<input checked="" type="checkbox"/>	.DNP3_FO3	REAL	61488	288	4	FO	1	202
<input checked="" type="checkbox"/>	.DNP3_FOB1	REAL	61472	52	4	FOB	1	200
<input checked="" type="checkbox"/>	.DNP3_FOB2	REAL	61472	56	4	FOB	1	201
<input checked="" type="checkbox"/>	.DNP3_FOB3	REAL	61472	60	4	FOB	1	202
<input checked="" type="checkbox"/>	.DNP3_FO4	REAL	61488	292	4	FO	1	203
<input checked="" type="checkbox"/>	.DNP3_FO5	REAL	61488	296	4	FO	1	204

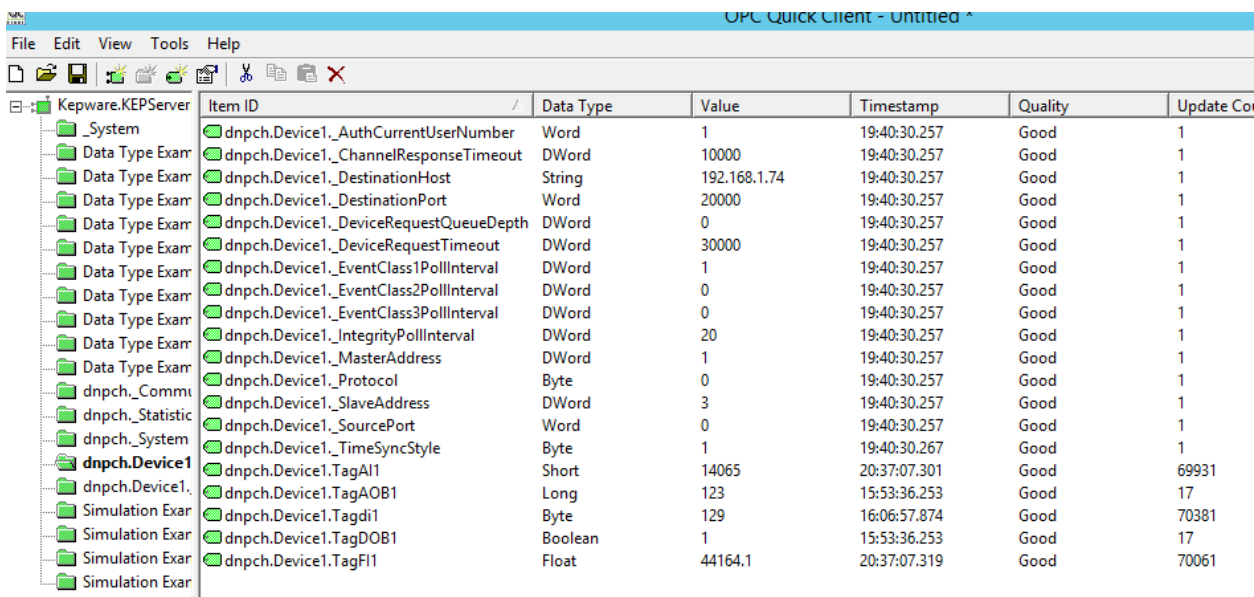
And finally map FOB to FO tags in TwinCAT:

```

0103
0104 DNP3_FO1 :=DNP3_FOB1;
0105 DNP3_FO2 :=DNP3_FOB2;
0106 DNP3_FO3 :=DNP3_FOB3;
0107

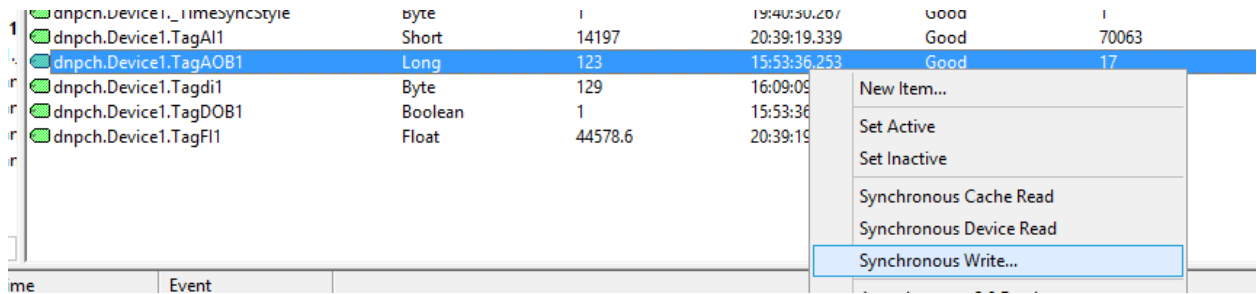
```

When you reinitialized kepware Server and connect by any OPC Client, you can see device tags as following image:

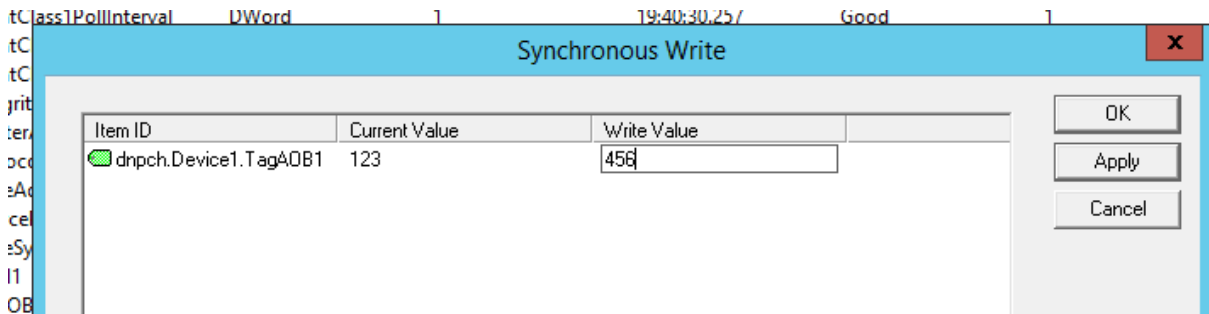


Please notice that you do not need to define AO and DO tags in Kepware . Kepware Server Will show value of DO and AO tags in DOB and AOB Tags .

For Writing to AOB and DOB Select Tag and right click and select Synch Write :

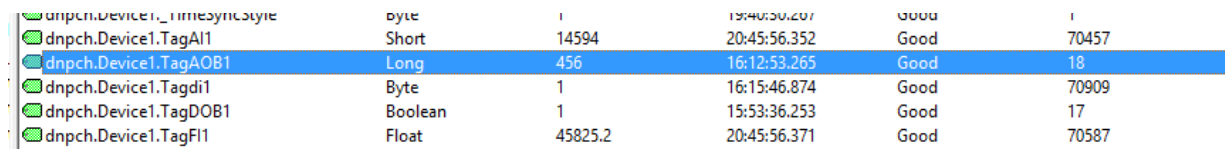


Enter new value for Tag and click on ok or apply .



Current value of tag in above example is value of AO tag that is read from RTU by Kepware Server and Write Value will send to RTU by DirectOperate Command .

After Kepserver wrote Value to RTU and server read AO feedback , then tag value will changed to Write Value .



10 – DNP Master Specification

- Following DNP Functions are not Supported in V3 RC5 :
File Transfer , Group 0 , Data Set , Virtual Terminal
- RS485 Mode is not supported. (no Collision Avoidance)
- Receiver Inter character Timeout : Not Checked
- UDP Datagram is not supported
- Confirmation in Data Link Layer is always Off .
- Group 12 (DOB) and 41 (AOB) Tags are sending one tag Per frame . Multiple Command in one Frame is not supported.
- Supported Qualifier :
 - Prefix 0 Range 0,1,2
 - Prefix 1 Range 7,8,9
 - Prefix 2 Range 7,8,9
 - Prefix 3 Range 7,8,9
- Supported Groups :
 - DI Group 1 , Variation 1,2,3
 - DI Group 2 : Variation 1 ,2
 - DPI Group 3 : Variation 2
 - DPI Group 4 : Variation 1 , 2
 - DO Group 10 : Variation 1,2
 - DO Group 11 : Variation 1 , 2
 - DOB Group 12 : Variation 1
 - CNT Group 20 : Variation 1 , 2, 5,6
 - CNT Group 21 : Variation 1,2,5,6,9,10

- CNT Group 22 : Variation 1 , 2, 5, 6
- CNT Group 23 : Variation 1 , 2, 5, 6
- AI Group 30 : Variation 1 , 2, 3, 4, 5, 6
- AI Group 32 : Variation 1,2,3,4,5,6,7,8
- AO Group40 : Variation 1,2,3,4
- AOB Group 41 : Variation 1
- AO Group 42 : Variation 1,2,3,4,5,6,7,8

11 – UTC Time Operation

When you want to send the time information of DNP tags to a master in UTC format, you must select the "Use UTC" box in the project configuration.

Controller | DNP Slave | DNP Master | About

Controller

CX Controller IP Address: 192.168.1.38 CX AMS netID: 5.46.239.133.1.1

Configuration Name: D:\tctest\simple

TC PLC Port No: 801 TC2 = 801 . TC3 = 851 Master Enable Use UTC

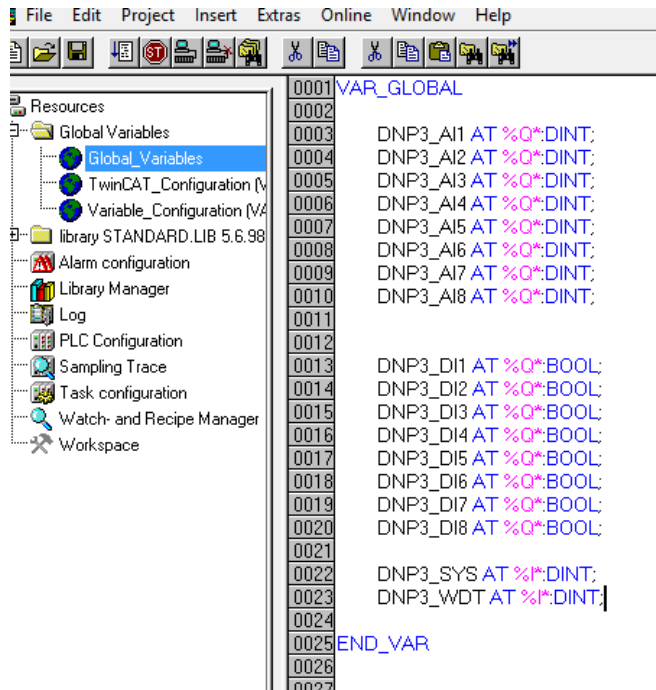
Master RS485 Gateway Mode Gateway Wait msec: []

Start Kernel with delay(Sec): 5

DNP Loop Delay: 50 msec DIE2 Loop Delay: 3 msec

When "Use UTC" is enabled, the RTU will send all time tag information in the UTC standard, regardless of what time zone is selected in the RTU. Also, the RTU expects the Time Synch command from the master to be in UTC format.

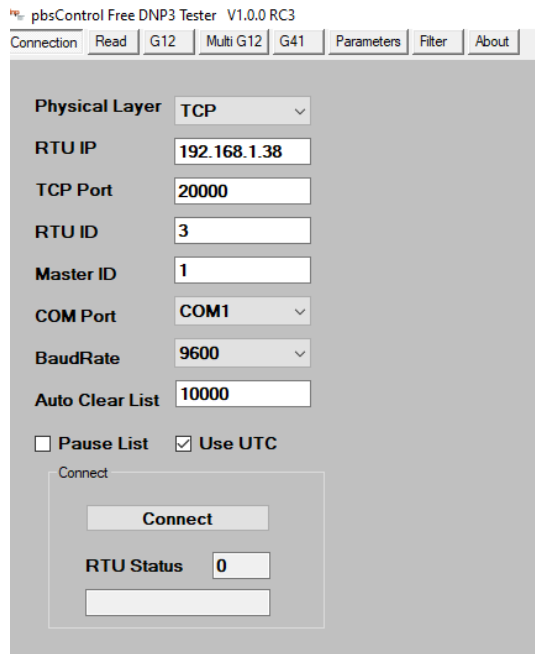
In the following example, we define 16 DNP Tags for CX controller and enabled UTC.



DNP Project is as following:

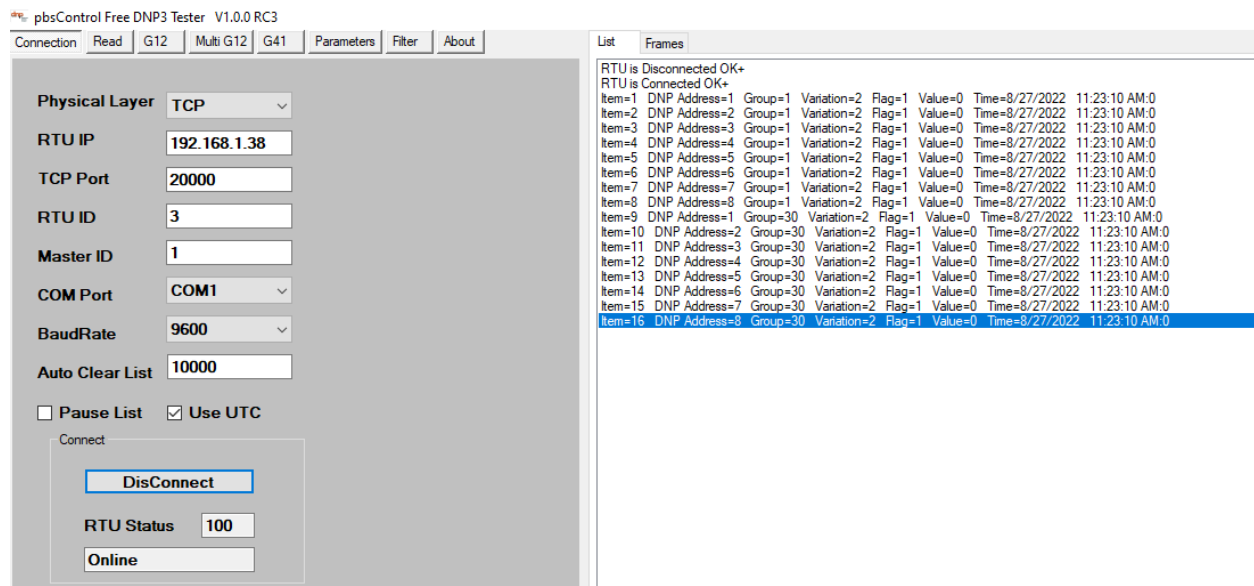
Controller DNP Slave DNP Master About									
Slave1 Slave2 Slave3 Slave4 Slave5 Slave6 Slave7 Digital Variations Analog Variations Tags									
Filter (Tag Name start with) .DNP3									
Active	Tag Name	Tag Com...	Type	Group	Group Off...	Grouplen	DNPTType	DNPCClass	DNPAddr.
<input checked="" type="checkbox"/>	.DNP3_AI1		DINT	61488	0	4	AI	1	1
<input checked="" type="checkbox"/>	.DNP3_AI2		DINT	61488	4	4	AI	1	2
<input checked="" type="checkbox"/>	.DNP3_AI3		DINT	61488	8	4	AI	1	3
<input checked="" type="checkbox"/>	.DNP3_AI4		DINT	61488	12	4	AI	1	4
<input checked="" type="checkbox"/>	.DNP3_AI5		DINT	61488	16	4	AI	1	5
<input checked="" type="checkbox"/>	.DNP3_AI6		DINT	61488	20	4	AI	1	6
<input checked="" type="checkbox"/>	.DNP3_AI7		DINT	61488	24	4	AI	1	7
<input checked="" type="checkbox"/>	.DNP3_AI8		DINT	61488	28	4	AI	1	8
<input checked="" type="checkbox"/>	.DNP3_DI1		BOOL	61489	256	1	DI	1	1
<input checked="" type="checkbox"/>	.DNP3_DI2		BOOL	61489	257	1	DI	1	2
<input checked="" type="checkbox"/>	.DNP3_DI3		BOOL	61489	258	1	DI	1	3
<input checked="" type="checkbox"/>	.DNP3_DI4		BOOL	61489	259	1	DI	1	4
<input checked="" type="checkbox"/>	.DNP3_DI5		BOOL	61489	260	1	DI	1	5
<input checked="" type="checkbox"/>	.DNP3_DI6		BOOL	61489	261	1	DI	1	6
<input checked="" type="checkbox"/>	.DNP3_DI7		BOOL	61489	262	1	DI	1	7
<input checked="" type="checkbox"/>	.DNP3_DI8		BOOL	61489	263	1	DI	1	8
<input checked="" type="checkbox"/>	.DNP3_SYS		DINT	61472	0	4	SYS	1	1
<input checked="" type="checkbox"/>	.DNP3_WDT		DINT	61472	4	4	WDT	1	1

Fop DNP master tester, you can use pbsFDT. Download pbsFDT from web site and connect to RTU as following image:



At connection tab select RTU IP, port and other parameters and select “Use UTC” Option. Then click on Connect Button.

If you have setup everything properly , FDT will connect to RTU and changing RTU Status to 100 that means FDT got Data from RTU .



RTU Status : 10 Connect physically

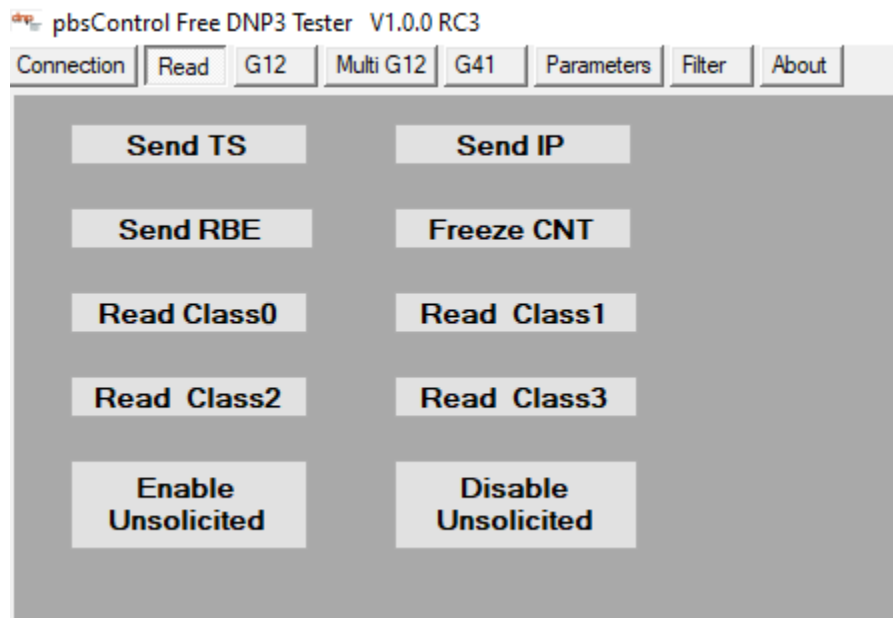
RTU Status 11 : Wait for reconnect to RTU

RTU Status 20 : FDT Send Time Synch

RTU Status 100 : FDT received Data from RTU

When FDT connect , it will send class 0 to RTU and showing all RTU tags at right list , as above image . In the tag list you can see Tag Address , variations , Flag , Value and time . Please notice that the time that is shown here is changed to Local Time . it means although RTU is sending data by UTC format , but because you select use UTC in FDT , so FDT will change DNP tag time to Local Time automatically .

For reading Events , you need to use Read Tab .



For reading all changes in the RTU , you can send RBE to RTU . RBE is requesting class1 , 2 , 3 from RTU .

In the following image we asked for RBE and you can see again all times as changed to Local Time automatically:

pbsControl Free DNP3 Tester V1.0.0 RC3

Connection | Read | G12 | Multi G12 | G41 | Parameters | Filter | About

Send TS Send IP

Send RBE Freeze CNT

Read Class0 Read Class1

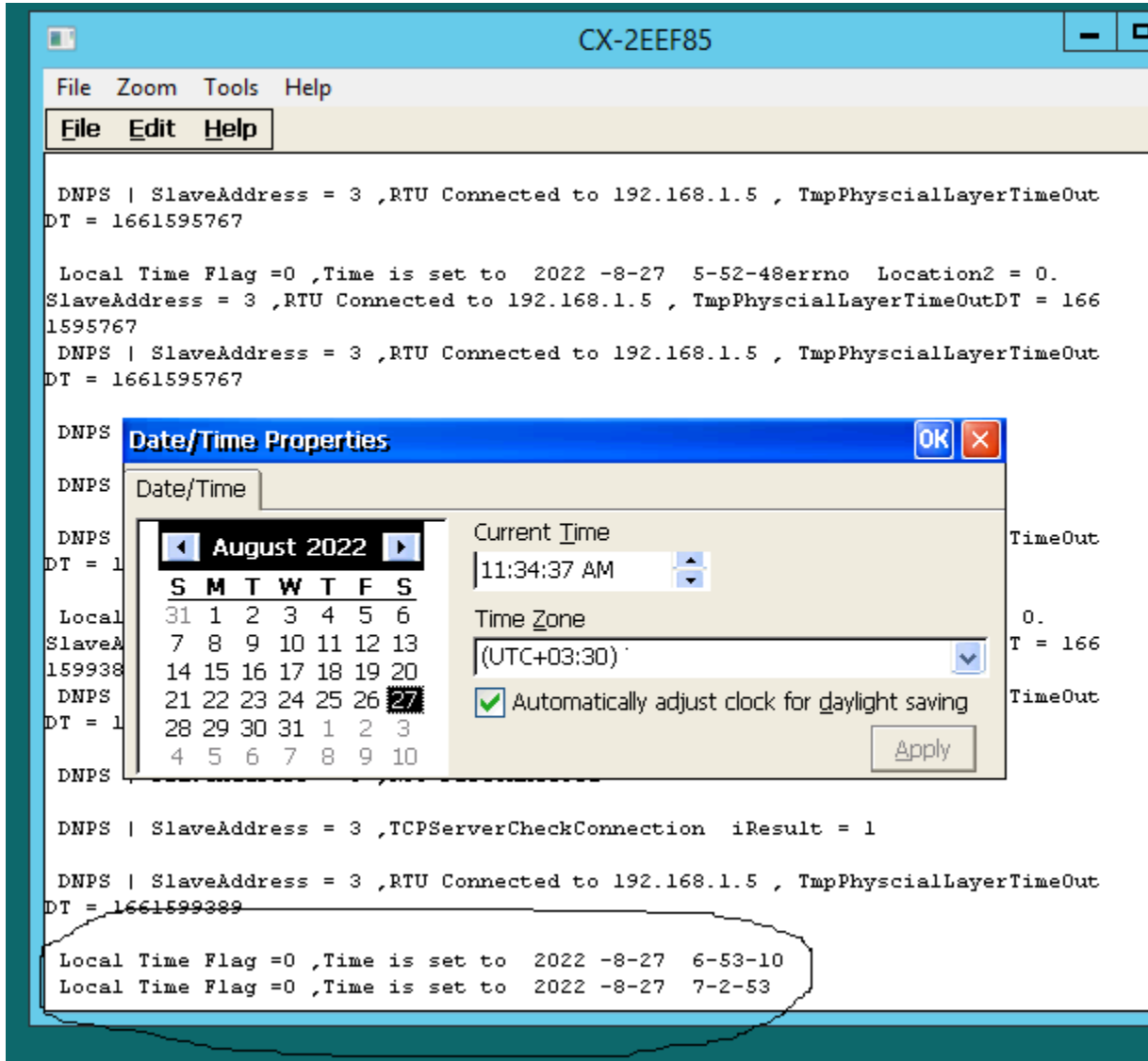
Read Class2 Read Class3

Enable Unsolicited Disable Unsolicited

Item	DNP Address	Group	Variation	Flag	Value	Time	Frames
Item=7	DNP Address=7	Group=1	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:23:10 AM:0
Item=8	DNP Address=8	Group=1	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:23:10 AM:0
Item=9	DNP Address=1	Group=30	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:23:10 AM:0
Item=10	DNP Address=2	Group=30	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:23:10 AM:0
Item=11	DNP Address=3	Group=30	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:23:10 AM:0
Item=12	DNP Address=4	Group=30	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:23:10 AM:0
Item=13	DNP Address=5	Group=30	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:23:10 AM:0
Item=14	DNP Address=6	Group=30	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:23:10 AM:0
Item=15	DNP Address=7	Group=30	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:23:10 AM:0
Item=16	DNP Address=8	Group=30	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:23:10 AM:0
Item=17	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:23:08 AM:93
Item=18	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:23:19 AM:75
Item=19	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:23:30 AM:82
Item=20	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:23:41 AM:88
Item=21	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:23:52 AM:64
Item=22	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:24:03 AM:70
Item=23	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:24:14 AM:83
Item=24	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:24:25 AM:110
Item=25	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:24:36 AM:67
Item=26	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:24:47 AM:18
Item=27	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:24:58 AM:89
Item=28	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:25:09 AM:109
Item=29	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:25:20 AM:84
Item=30	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:25:31 AM:96
Item=31	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:25:42 AM:5
Item=32	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:25:53 AM:38
Item=33	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:26:04 AM:91
Item=34	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:26:15 AM:102
Item=35	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:26:26 AM:60
Item=36	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:26:37 AM:99
Item=37	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:26:48 AM:34
Item=38	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:26:59 AM:62
Item=39	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:27:10 AM:28
Item=40	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:27:21 AM:79
Item=41	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:27:32 AM:93
Item=42	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:27:43 AM:53
Item=43	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:27:54 AM:80
Item=44	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:28:05 AM:73
Item=45	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:28:16 AM:113
Item=46	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:28:27 AM:65
Item=47	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:28:38 AM:79
Item=48	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:28:49 AM:99
Item=49	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:29:00 AM:60
Item=50	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:29:11 AM:92
Item=51	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:29:22 AM:106
Item=52	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:29:33 AM:64
Item=53	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:29:44 AM:98
Item=54	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:29:55 AM:95
Item=55	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:30:06 AM:130
Item=56	DNP Address=1	Group=2	Variation=2	Flag=1	Value=1	Time=8/27/2022	11:30:17 AM:70
Item=57	DNP Address=1	Group=2	Variation=2	Flag=1	Value=0	Time=8/27/2022	11:30:28 AM:96

For Time synchronizing, you can see TS Command, and then FDT will send time to RTU by UTC format.

In RTU you can see time that is sent to RTU.



EOD