

# BECKHOFF

# DNP3 Slave Driver User Manual



[www.pbsControl.com](http://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 Functionality to driver , adding driver boot delay	May - 2015
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

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## 1 – Introduction

pbsControl company developed DNP3 Slave driver for BECKHOFF CX Series Controllers . DNP3 Driver is compatible with WinCE5.0, WinCE6.0 and Win32 .Please refer to [www.beckhoff.com](http://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](mailto:kb@pbscontrol.com)

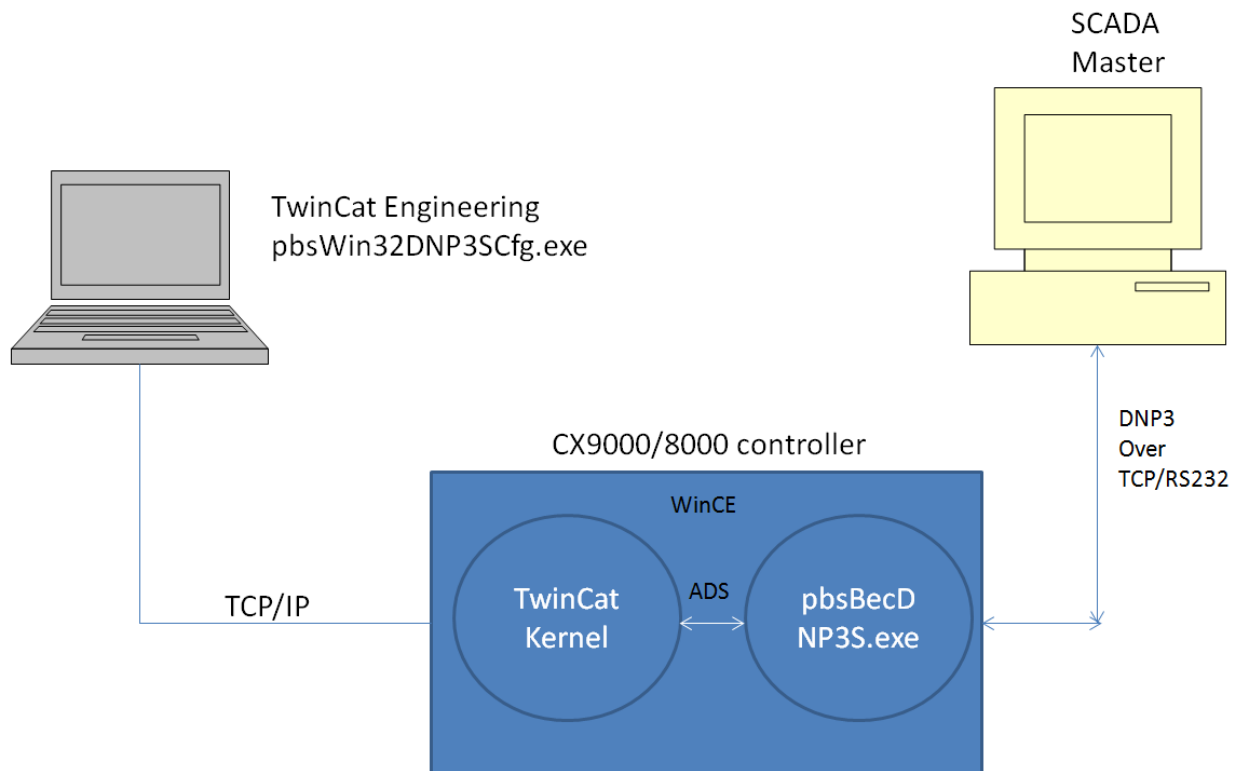
Driver license is linked to MACID of controller. Driver is running for 30 min without license as demo purpose. For each Controller you need to purchase separate license.

Driver is tested with TwinCat 2 and TwinCat 3 .

## 2 – Driver Structure and installation

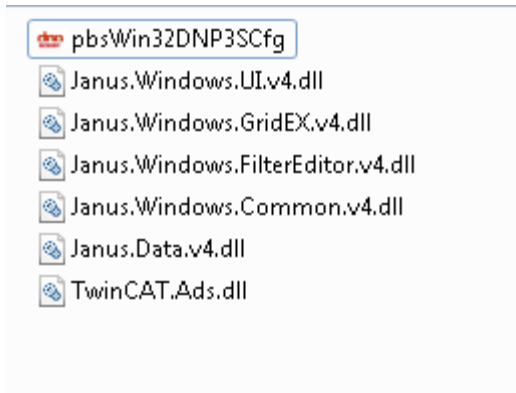
DNP3 Driver has following components:

- Configurator utility which is running on windows operating system. Configurator is developed by DotNet3.5. So you need to have DotNet 3.5 runtime engine on Configuration PC. (pbsWin32DNP3SCfg.exe)
- DNP3 Runtime kernel on CX9000/CX8000/CX1000 Controllers. (pbsBecDNP3SV2.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 for reading/Writing TwinCat variables and from the other side is communicating with DNP3 Driver.



Download DNP3 Slave Configurator utility from [www.pbscontrol.com](http://www.pbscontrol.com) and unzip it at any path in configuration PC.

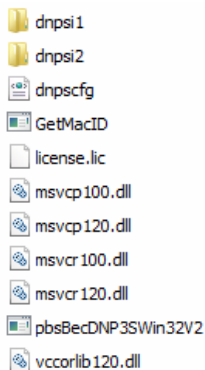
You can see following files:



- 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](http://www.pbscontrol.com)

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



Put pbsBecDNP3sV2.exe at WinCE Startup. Search “Automatic Start of CE Applications” in Beckhoff Information system.

For win32 runtime kernel put pbsBecDNP3SWin32V2.exe kernel at windows auto startup folder.

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 .

Dnpscfg.xml is configuration file which is make by configurator utility.

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.

### 3- Driver Configuration

Run pbsWin32DNP3SCfg.exe utility. You will see following page:

The screenshot shows the 'DNP3 Slave configurator for Beckhoff CX controller Ver 2.0.0' window. It has a menu bar with 'Controller', 'Tags', and 'About'. The main area is divided into two sections: 'Controller' and 'Physical layer DNP3'.  
In the 'Controller' section, there are four input fields: 'CX Controller IP Address' (10.71.1.20), 'CX AMS netID' (10.71.1.20.1.1), 'Configuration Name' (C:\share\DNP3\vt\dnp3cfg.xml), and 'TC PLC Port No' (801). Below these, it says 'TC2 = 801 , TC3 = 851'.  
The 'Physical layer DNP3' section has a 'Physical Layer' box with two radio buttons: 'TCP' (checked) and 'RS232'. Below this are several input fields: 'Serial Port' (1), 'Second Serial Port' (2), 'Baudrate' (19200), 'Second Baudrate' (19200), 'TCP Port' (20000), 'Second TCP Port' (20001), 'Start Kernel with delay(Sec)' (5), and 'TC Writes Change signals every' (100) msec to DNP3 Kernel.

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 .

Select physical layer TCP or RS232.

**Serial Port**: Port Number for communication in RS232 Mode for first driver instance .

**Second Serial Port**: Port Number for Second driver instance.

**Baudrate** : communication Baud Rate for first driver instance.

**Second Baudrate** : communication Baud Rate for second driver instance.

**TCP Port** : TCP Communication port number for first driver instance . By Default DNP3 port number is 20000.

**Second TCP Port** : TCP Communication port number for Second driver instance . It is better to use different port number for second driver instance like 20001

**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 .

Before using DNP3 Configurator , 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.

You can select physical layer for communication and set parameters for DNP3 slave driver in Controller page.

The screenshot shows the 'DNP3 Slave configurator for Beckhoff CX controller Ver 2.0.0' window. It has a 'Controller' tab selected. The 'Controller' section contains the following fields:

- CX Controller IP Address: 10.71.1.20
- CX AMS netID: 10.71.1.20.1.1
- Configuration Name: C:\share\DNP3\vt\dnp3cfg.xml
- TC PLC Port No: 801
- TC2 = 801, TC3 = 851

The 'Physical layer' section is set to 'DNP3' and contains the following fields:

- Master Address: 4
- Second Master Enable:
- CX Controller Address: 3
- Second Master Address: 5
- Master IP Address: 10.71.1.50
- Second Master IP Address: 10.71.1.20
- Max Application Frame size: 1024
- SBO Timeout(Sec): 5
- No Communication Timeout (sec): 60 (0 = Disable)

**Master Address:** DNP3 master SCADA address for first driver instance. Ask from master SCADA Administrator.

**Second Master Address:** DNP3 master SCADA address for Second driver instance. Ask from master SCADA Administrator.

**Second Master Enable:** if you have two master in the network, then you need to enable it. Otherwise uncheck this option.

**CX Controller address:** DNP3 slave Address for CX Controller.

**Master IP Address:** DNP3 master SCADA IP address for first driver instance

**Second IP Address:** DNP3 master SCADA IP address for Second driver instance

**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.

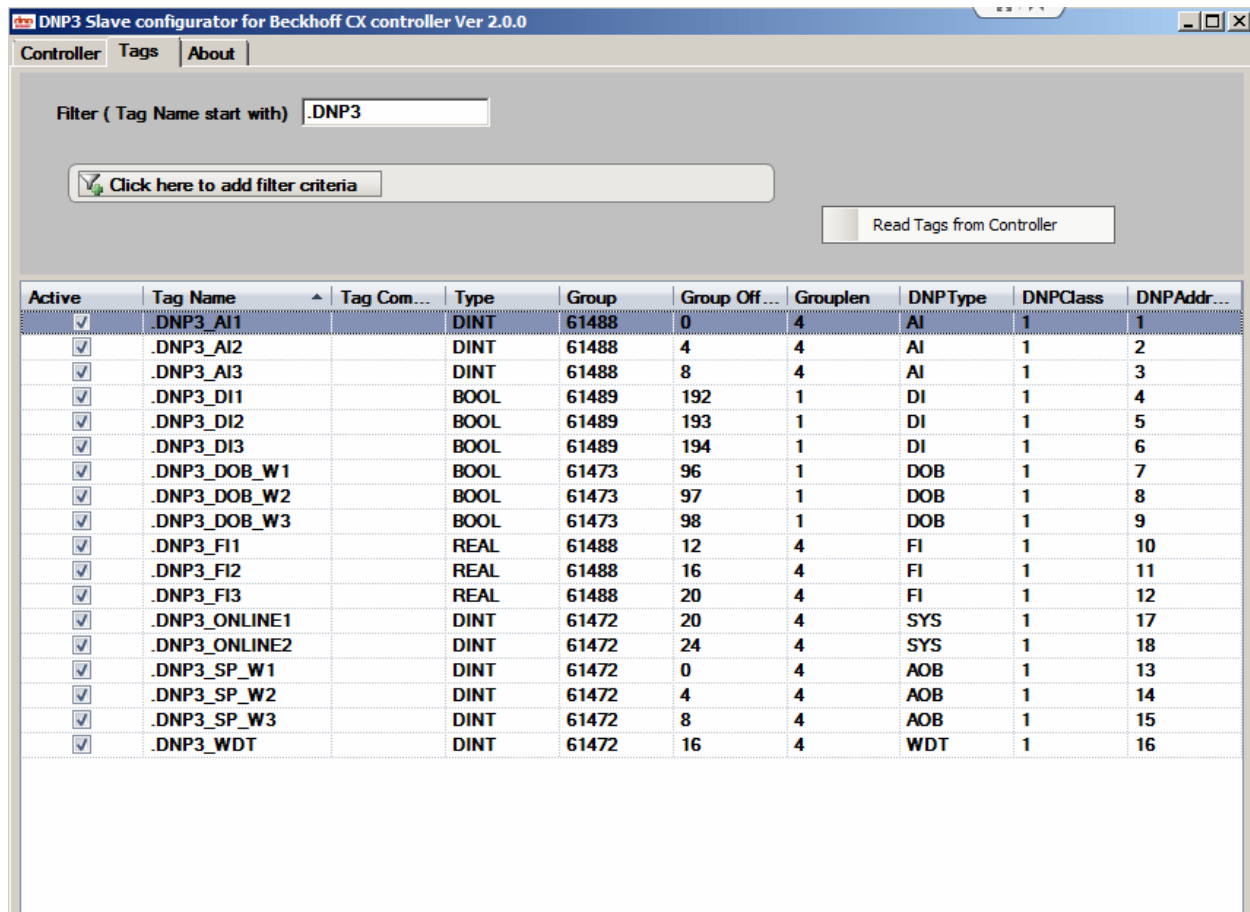
**SBO timeout (Sec):** select before Operation time out for AOB and DOB tags.

**No communication Timeout (sec):** This parameter is used in TCP 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. No Communication Timeout 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 No communication Timeout more than keep alive timer .For above sample you can set 80 sec.

If No communication Timeout is 0, above functionality is disable and DNP3 Driver is not checking master communication request timeout.

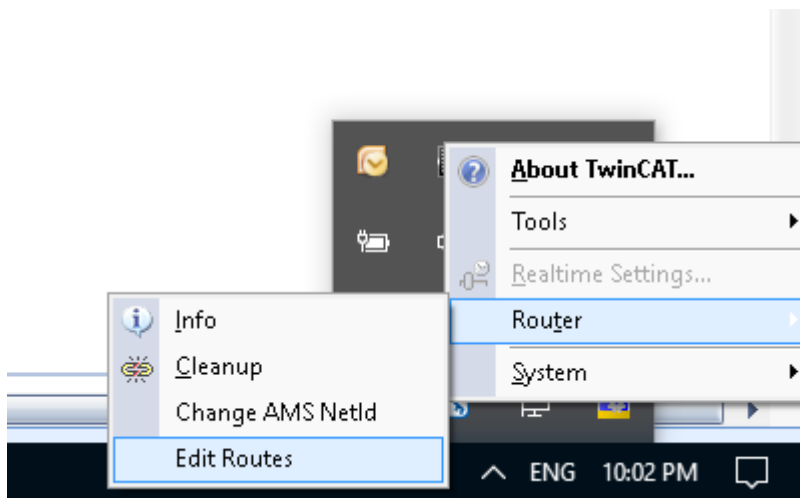
For reading TwinCat Tags from controller and configuration of tags for DNP3 protocol, you should use Tags Page.



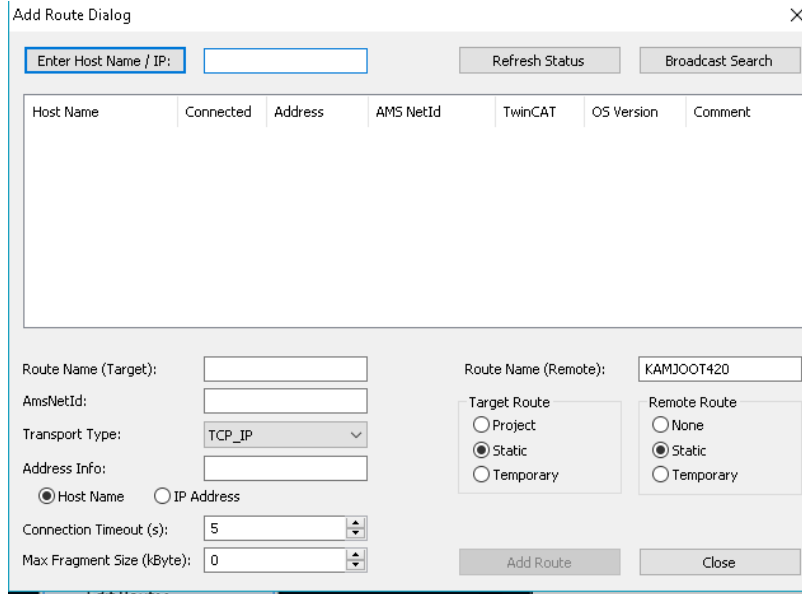
***For reading tags from CX Controller, right click on Tags page and execute read tags from controller.*** It will read all TwinCat Tags from controller that start with Filter field. Because there are many systematic tags inside CX Controllers, so it is better to define DNP3 tags for your logic and start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

just DNP3 tags by configurator and make setting for each tag.

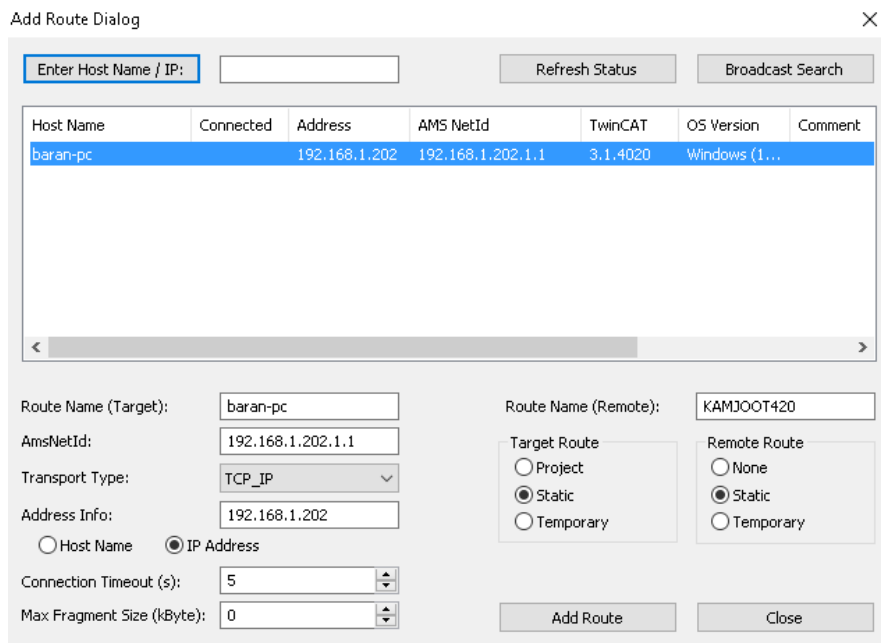
Important Point: you should Install TC ADS Utility in Engineering station and add Controller AMSID in to router table of Engineering station. Otherwise you will get Timeout when you want to read tags from controller.



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



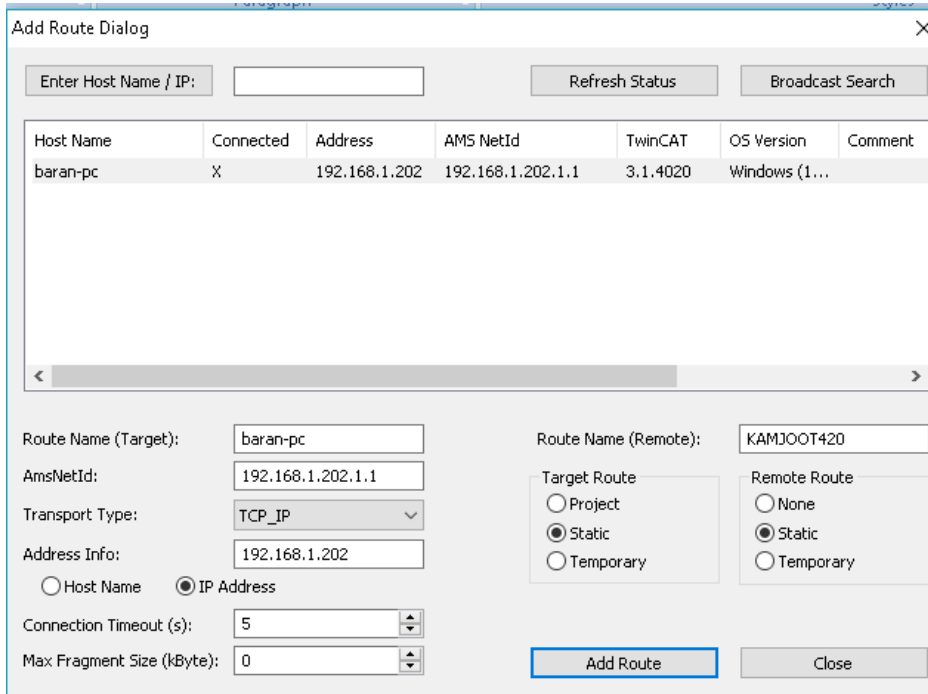
Normally it is better to set Address Info on IP Address and click on Broadcast search as following :



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
- 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.

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

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

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

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

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

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

DNP3 function codes which are implemented:

- Read class 0,1,2,3,4
- Integrity command

- Read Event by exception ( RBE)
- Time synchronization
- Enable /Disable unsolicited communications ( Transfer data from RTU to Master SCADA )
- Dynamic Class assign
- Freezing counters
- Write

### DNP3 Slave driver Operation:

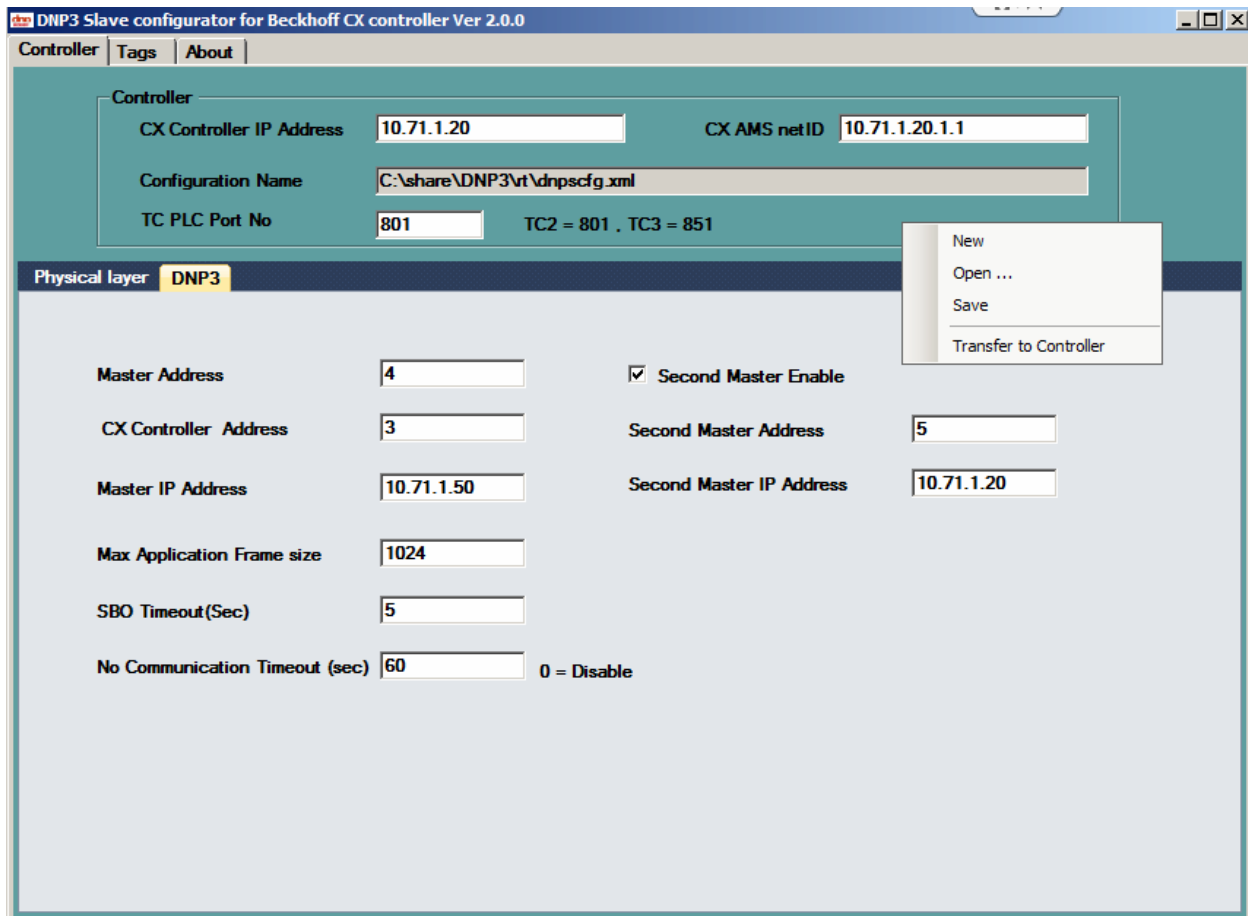
1 - Master SCADA will read all Input Signals ( DI , AI , FI , DO , AO , DPI)

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

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

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

For saving configuration file to a local file on your PC, select Controller page, and right click there. 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.

```
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_W AT %I*: DINT;
0034     DNP3_SP2_W AT %I*: DINT;
0035     DNP3_SP3_W AT %I*: DINT;
0036     DNP3_SP4_W AT %I*: DINT;
0037
0038     DNP3_DOB1_W AT %I*: BOOL;
0039     DNP3_DOB2_W AT %I*: BOOL;
0040     DNP3_DOB3_W AT %I*: BOOL;
0041     DNP3_DOB4_W AT %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 and DOB tags in your logic.

AOB is analog Output Block and DOB is digital Output Block. When SCADA Master wants to write AO and DO tags to Controller, you should define DNP3 AOB and DOB Tag type. In TwinCat AOB 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: There is no limitation in number of TwinCat DNP3 Variables.

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.

Active	Tag Name	Tag Comm...	Type	Group	Group Offset	GroupLen	DNPTyp	DNPClass	DNPAddress
<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_DI1		BOOL	61489	192	1	DI	1	1
<input checked="" type="checkbox"/>	.DNP3_DI2		BOOL	61489	193	1	DI	1	2
<input checked="" type="checkbox"/>	.DNP3_DI3		BOOL	61489	194	1	DI	1	3
<input checked="" type="checkbox"/>	.DNP3_FI4		REAL	61488	12	4	FI	1	4
<input checked="" type="checkbox"/>	.DNP3_FI5		REAL	61488	16	4	FI	1	5
<input checked="" type="checkbox"/>	.DNP3_FI6		REAL	61488	20	4	FI	1	6
<input checked="" type="checkbox"/>	.DNP3_SP1_W		DINT	61472	0	4	AOB	0	1
<input checked="" type="checkbox"/>	.DNP3_SP2_W		DINT	61472	4	4	AOB	0	2
<input checked="" type="checkbox"/>	.DNP3_SP3_W		DINT	61472	8	4	AOB	0	3
<input checked="" type="checkbox"/>	.DNP3_SP_W		DINT	61472	12	4	AOB	0	4

## 5 – System Tags

Two new Tag Types is provided in Ver 1.3 of driver.

**SYS:** This is like AOB Tag and use same address space of AOB, But its Type is SYS. SYS tag is showing Connection Status with master SCADA in TCP Connection. 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 . First SYS Tag will link to first driver instance and second SYS tag is linked to second Driver instance .

Define an INT Tag in Twincat for SYS as following:

```
DNP3_SYS AT %I: INT ;  
DNP3_WDT AT %I: INT ;
```

At DNP3 Configurator , use SYS type for DNP Tag type and use same DNP3 address space as AOB . Means you couldn't have SYS tag and any AOB Tag with same DNP Address.

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 is like AOB Signal and using same address space of AOB and SYS Tag.

Define an INT Tag in Twincat for WDT as following:

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

At DNP3 Configurator , use WDT type for DNP Tag type and use same DNP3 address space as AOB and SYS . Means you couldn't have WDT tag and any AOB/SYS Tag with same DNP Address.

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

## 6 – Device Profile

Please download pbsSoftlogic DNP3 slave device profile from [www.pbscontrol.com](http://www.pbscontrol.com)

## 7 – Automatic RTU Restarting

When there is no communication between TC and DNP3 Kernel (From TC Side) for more than 30 Min, then DNP3 Kernel will automatically Restart RTU.

We put this functionality as extra watch dog between TC and DNP3 Kernel.

So you should make a pulse train (1 Min High, 1 Min Low as an example) from TC to DNP3 Kernel, always writing by TC to DNP3 Kernel for not restarting RTU when there is no Communication between TC and DNP3 Kernel.

If any problem happening between TC and DNP3 Kernel and tags are not written between TC and DNP3 Kernel, then RTU will restart after 30 Min.

EOD