DNP3 Outstation

using COPA-DATA stack

straton user guide – Rev. 4

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CP_R31_006_H

straton

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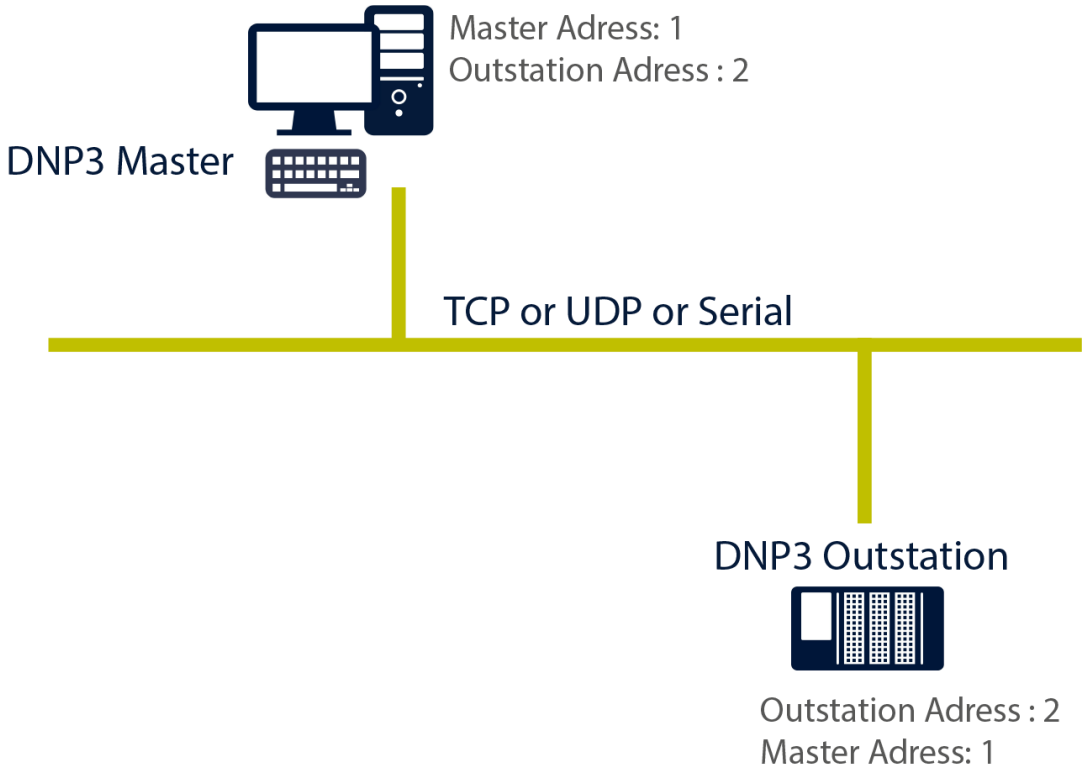
1. Install straton Editor and Runtime

Download and install from https://straton-plc.com/telechargements/

2. Architecture

The DNP3 communication required the declaration of CONNECTION/SESSION, each connection/session can have its own communication parameters.

Variables are refreshed in polling mode and/or in event mode, the data are group by Type, events are assigned to a Class. In the configuration default values are set for all these information's but they can be overwritten.



3. Configuration in straton

Open the IO Drivers window using the tool bar ( ) or right click on the project > Insert Shortcut > Fieldbus configurations

Insert a new Fieldbus using the tool bar ( ) or menu Insert > Insert configuration and select the "DNP3 Outstation CD" driver.

DNP3 Outstation:

Property	Description
DNP3 loop time	Refresh rate of DNP3 stack
Log Traces	Display warning messages in the output
Default Class Event	
(2) Binary input event (4) Double bit input event (11) Binary output event (22) Counter event (23) Frozen Counter event (32) Analog input event (42) Analog output event status (111) Octet string event	Specifies the class that will be used if Default is selected for a point's Event Class property
Default variation	
(1) Binary input (2) Binary input event (3) Double bit input (4) Double bit input event (10) Binary output (11) Binary output event (20) Counter (21) Frozen counter (22) Counter event (23) Frozen counter event (30) Analog input (32) Analog input event (40) Analog output status (42) Analog output event status	Specifies the variation that will be used if Default is selected for a point's Static Variation or Event Variation properties.

Property	Description
Event Mode	
(2) Binary input event (4) Double bit input event (11) Binary output event (22) Counter event (23) Frozen Counter event (32) Analog input event (42) Analog output event status (111) Octet string event	Specifies the event mode that will be used for unsolicited responses: ALL : Sequence of Events, return all events in chronological order MOST RECENT : Most Recent, return only the most recent event for each point
Unsolicited messages	
Unsolicited retry number	Specify the maximum number of unsolicited retries before changing to the 'offline' retry period. This parameter allows you to specify up to 65535 retries.
Unsolicited retry delay	Specifies the time to delay after an application confirm timeout before retrying the unsolicited response.
Unsolicited events number Class 1 Class 2 Class 3	If unsolicited responses are enabled, Unsolicited events number specifies the maximum number of events in the corresponding class to be allowed before an unsolicited response will be generated unless the Unsolicited events delay has expired.
Unsolicited events delay Class 1 Class 2 Class3	If unsolicited responses are enabled, Unsolicited events delay specifies the maximum amount of time after an event in the corresponding class is received before an unsolicited response will be generated unless the Unsolicited events number is exceeded first.
Misc	
Self address enable (code 0xFFFC)	Specify whether or not to enable self address functionality on this outstation device. Outstation will respond to address 0xfffc as though it received a request for its configured address. It will respond with its own address so the master can automatically discover the outstation address.

Property	Description
Clock valid period	Specifies how long to wait after receiving a time synchronization before requesting the next time synchronization.
Application confirm timeout	Application confirm timeout specifies how long the outstation DNP device will wait for an application layer confirmation from the master. This in combination with Unsolicited retry delay or Unsolicited offline retry delay will determine how frequently an unsolicited response will be resent.
Select timeout	This specifies the maximum amount of time for an output point that a select will remain valid before the corresponding operate is received. If an operate request is received after this period has elapsed the operate request will fail.
Time synchronization enable	If TRUE the system time of the outstation is updated according to the master
Restart enable	If TRUE a restart is performed after a restart request from the master
File transfer timeout	This specifies the maximum amount of time between file operations (read or write) on an open file before the file is automatically closed.
File transfer path	Path for ingoing/outgoing file
OEM Options	Reserved

Insert a CONNECTION using tool bar ( ) or menu Insert > Insert Master/Port. A CONNECTION describes the physical layer of DNP3

Channel:

Property	Description
Connection name	Name of the connection
Mode	Select serial or TCP/IP or UDP connection
Master Link	For Ethernet: IP address of the server For SERIAL: Settings of the serial port: "COM1:9600,N,8,1"
Data Link timeout	Link connection Timeout
Local Link	For PC with more than on Ethernet card select the IP address and port of the Ethernet card used for DNP3 Can be useful for multi connections
OEM Options	Reserved
Buffer Event size	Number of data change saved by the outstation in case of unconnected. These data will be sent as soon as the connection with the Master is (re)established

Insert a SESSION using tool bar ( ) or menu Insert > Insert Slave/Data block. A SESSION contains various parameters for DNP3 communication.

Session:

Property	Description
Session ID	Identifier of the session (Number)
Outstation address	Outstation address in this session
Master address	Master address in this session
Keep alive	Zero not activated or time in ms (Default deactivated)
Enable unsolicited messages	Enable unsolicited class 1, 2 and 3
Use UTC time base	Use UTC time for time stamp
OEM options	Options

OEM options:

- Bit 0: If true, variable status bits are used from the straton database.
- Bit 1: If true, timestamps are used from the straton database.

Insert variables using tool bar ( ) or menu Insert > Insert Variable…

Variables:

Property	Description
Symbol	Variable name
Type	(1) Binary inputs, (3) Double Inputs, (10) Binary Output Status, (20) Running Counters , (21) Frozen Counters, (30) Analog inputs, (40) Analog Output Status, (110) String Data
Point number	Point number (Max 65535)
Event class	The class to which events generated for this point will be assigned to. If set to NONE then the point will not generate events.
Static variation	The variation to return when the master request variation 0 on a static (class 0) poll
Event variation	The variation to return when the master request variation 0 on an event (class 1, 2 or 3) poll
Control action	Used to get control of SBO sequence from straton project using UDFB

Note: Variable status and time stamp are stored in straton database if the option is activated and if the symbol variable is embedded. Please refer to the section Variable status bits in the straton IDE online help.

4. Interoperability

To establish the communication between a Master device and an Outstation, some configurations have to be respected when using the DNP3 protocol in a Straton application. This concerns the *Static-Variation* and the *Event-Variation* of each type of data, the available configurations are:

Object number (*)	Variation number (**)	Description
1	0	Binary Input – Any Variation
1	1 (default)	Binary Input Packed format
1	2	Binary Input With flags
2	0	Binary Input Event – Any Variation
2	1	Binary Input Event without Time
2	2	Binary Input Event with Absolute Time
2	3 (default)	Binary Input Event with Relative Time
3	0	Double Bit Input – Any Variation
3	1 (default)	Double-bit Input Packed format
3	2	Double-bit Input With flags

4	0	Double Bit Input Event – Any Variation
4	1	Double Bit Input Event without Time
4	2	Double Bit Input Event with Absolute Time
4	3 (default)	Double Bit Input Event with Relative Time
10	0	Binary Output – Any Variation
10	2 (default)	Binary Output Status with flags
11	0	Binary Output Event – Any Variation
11	1 (default)	Binary Output Event without Time
11	2	Binary Output Event with Time
20	0	Binary Counter – Any Variation
20	1	32-bit Binary Counter with Flag
20	2	16-bit Binary Counter with Flag
20	5 (default)	32-bit Binary Counter without Flag
20	6	16-bit Binary Counter without Flag
21	1	32-Bit Frozen Counter with Flag
21	2	16-Bit Frozen Counter with Flag
21	5	32-Bit Frozen Counter with flag and time
21	6	16-Bit Frozen Counter with flag and time
21	9 (default)	32-Bit Frozen Counter without Flag
21	10	16-Bit Frozen Counter without Flag

Object number (*)	Variation number (**)	Description
22	0	Counter Event – Any Variation
22	1 (default)	32-Bit Counter Event with Flag
22	2	16-Bit Counter Event with Flag
22	5	32-Bit Counter Event with Flag and Time
22	6	16-Bit Counter Event with Flag and Time
23	0	Frozen Counter Event
23	1 (default)	32-Bit Frozen Counter Event with Flag
23	2	16-Bit Frozen Counter Event with Flag
23	5	32-Bit Frozen Counter Event with Flag and Time
23	6	16-Bit Frozen Counter Event with Flag and Time
30	0	Analog Input – Any Variation
30	1	32-Bit Analog Input with Flag
30	2	16-Bit Analog Input with Flag
30	3 (default)	32-Bit Analog Input without Flag
30	4	16-Bit Analog Input without Flag
30	5	Single-prec flt-pt Analog Input with flag

30	6	Double-prec flt-pt Analog Input with flag
32	0	Analog Input Event – Any Variation
32	1 (default)	32-Bit Analog Input Event without Time
32	2	16-Bit Analog Input Event without Time
32	3	32-Bit Analog Input Event with Time
32	4	16-Bit Analog Input Event with Time
32	5	Single-prec flt-pt Analog Input Event without Time
32	6	Double-prec flt-pt Analog Input Event without Time
32	7	Single-prec flt-pt Analog Input Event with Time
32	8	Double-prec flt-pt Analog Input with Time
40	0	Analog Output Status
40	1	32-Bit Analog Output Status
40	2 (default)	16-Bit Analog Output Status
40	3	Single-prec flt-pt Analog Output with flag
40	4	Double-prec flt-pt Analog Output with flag
42	0	Analog Output Event – Any Variation
42	1 (default)	32-Bit Analog Output Event without Time
42	2	16-Bit Analog Output Event without Time
42	3	32-Bit Analog Output Event with Time
42	4	16-Bit Analog Output Event with Time
42	5	Single-prec flt-pt Analog Output Event without Time
42	6	Double-prec flt-pt Analog Output Event without Time
42	7	Single-prec flt-pt Analog Output Event with Time
42	8	Double-prec flt-pt Analog IOutput Event with Time

(*) See technical documents from dnp3.org for more details
(**) Variation 0 is used to request the default variation

5. Multi-master configuration

The DNP3 protocol uses port number 20000 to establish a connection between devices, but other ports can be opened, for example if one wants to use more than one Master accessing the same Outstation.

In this example two DNP3 Masters are used to access the same Outstation. In the Fieldbus Configuration ( ) add another connection ( ) and another session ( ).

(See part 3 of this document)

Session configuration:

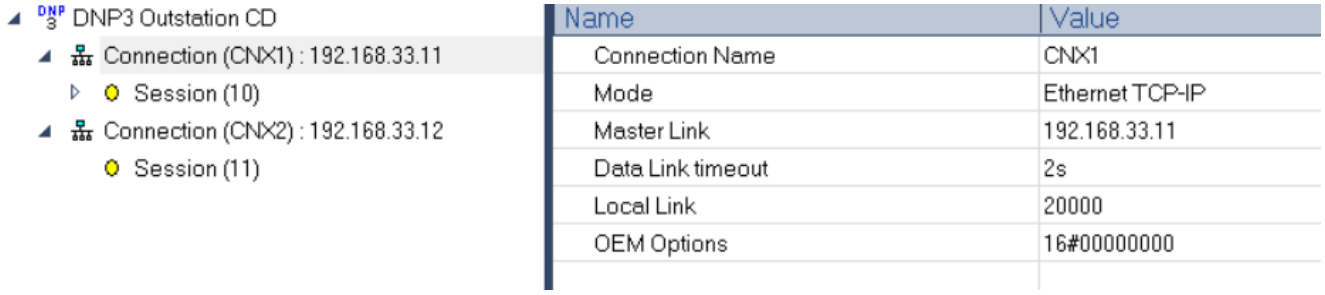
The *Session ID* must be unique for the entire Outstation configuration. For the new session, select a different ID from the previous session.

Channel configuration:

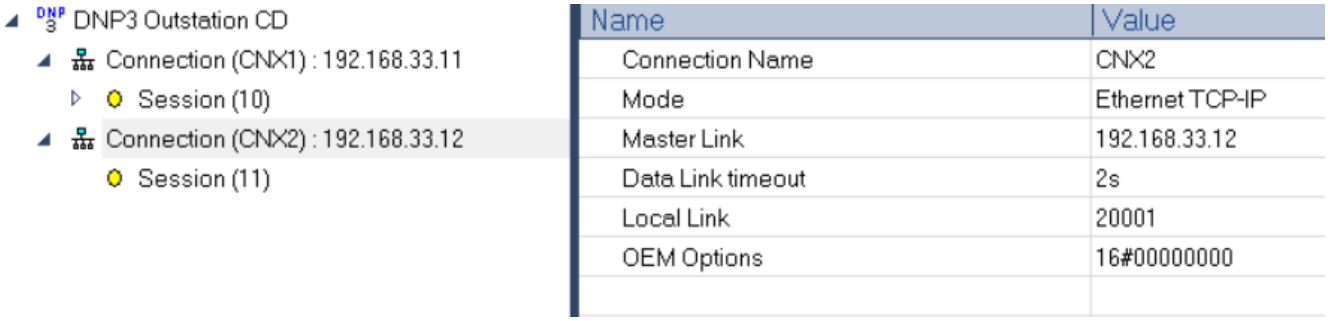
As it was said before, some different ports must be opened to access the same outstation, in our example the data will be exchanged on port 20000 and on port 20001.

In the straton editor one finally has the following Fieldbus Configurations:

Outstation connected to 1st master IP 192.168.33.11 using local port 20000



Outstation connected to 2nd master IP 192.168.33.12 using local port 20001

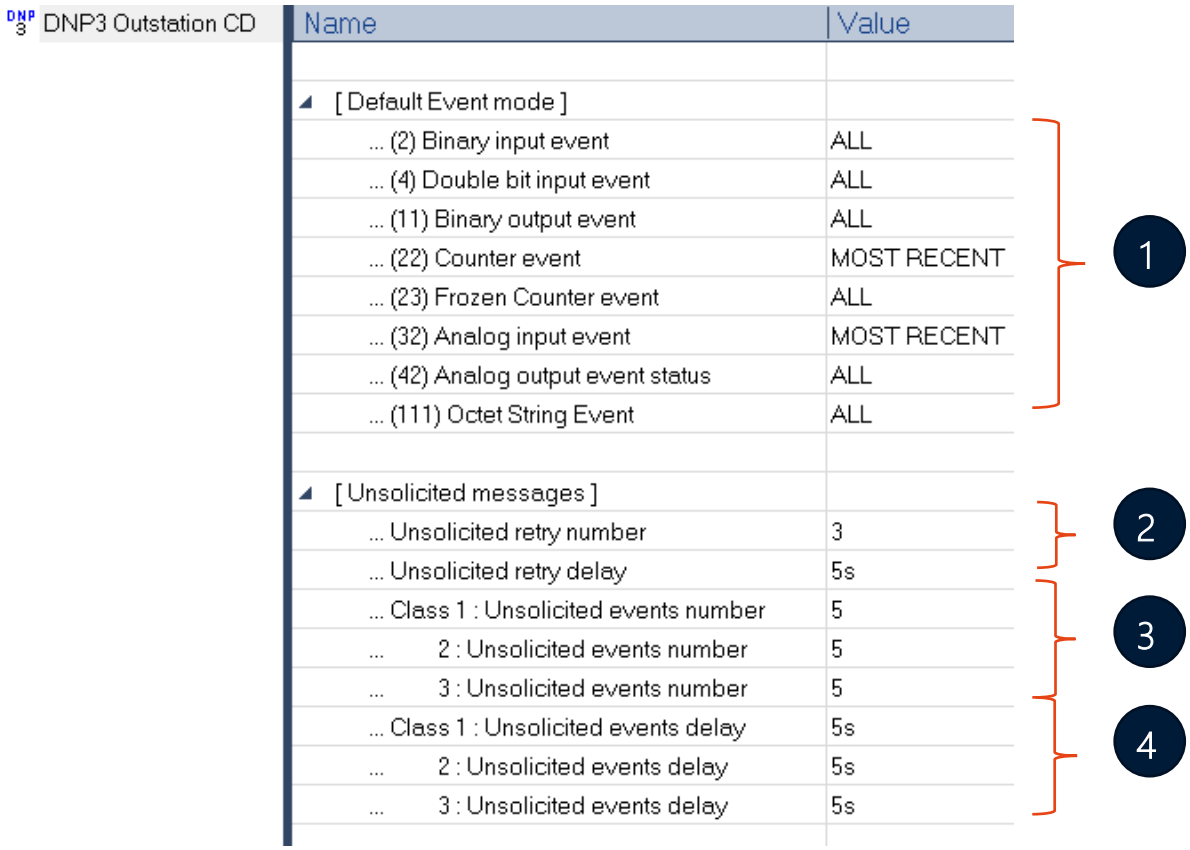


Always add a new connection to add a new session.

6. How to configure unsolicited events

Unsolicited events are called every time an input state is changing.

Here are some explanations on the different parameters available when clicking on the Slave node, in the Fieldbus configuration:



- Default Event mode (linked with points 3. and 4.):
- MOST RECENT: only the most recent point variation will be sent to the Master
- ALL: all the latest point variations will be sent to the Master
- This part concerns the unsolicited messages, sent to the Master for every kind of data which have an event class different than 'NONE'.
- The outstation will wait to have enough events (here 5) to send them to the Master.
- If the events number is not reached within this delay (here 5s) the available events are sent to the Master (see the example)

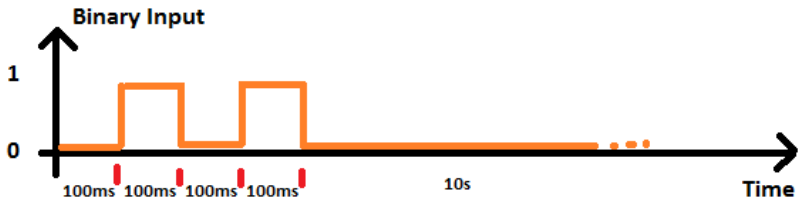
Example:

In this example Binary Inputs are used with a Time-Stamp, so one will be able to analyze the inputs' variations.

Its Static Variation is 1 (Packed format) and its Event Variation is 2 (With absolute time). The Event Class has to be different than NONE.

Name	Value
Symbol	B1
Type	(1) Binary Inputs
Point number	1
Event class	TWO
Static variation	1
Event variation	2
Control action	

This input will follow this scheme; its state is changing 4 times every 10s:



Here are some different configurations, Unsolicited Event Delay parameter is 5s:

Default Event mode	Unsolicited event number	Data sent is […]	[…] how many times after last changing ?
MOST RECENT	5	The last one	5s
MOST RECENT	4	The last one	Some milliseconds*
ALL	5	All the four data at the same time	5s
ALL	4	All the four data at the same time	Some milliseconds*
ALL	1	All the four data in four different packets	One packet every ≈100ms

* The input state is changing four times so the event number is reached, data can be sent

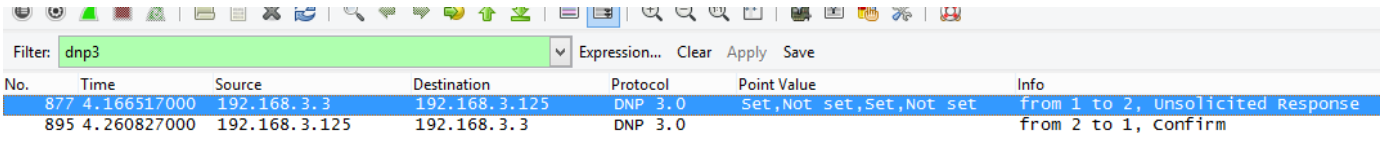
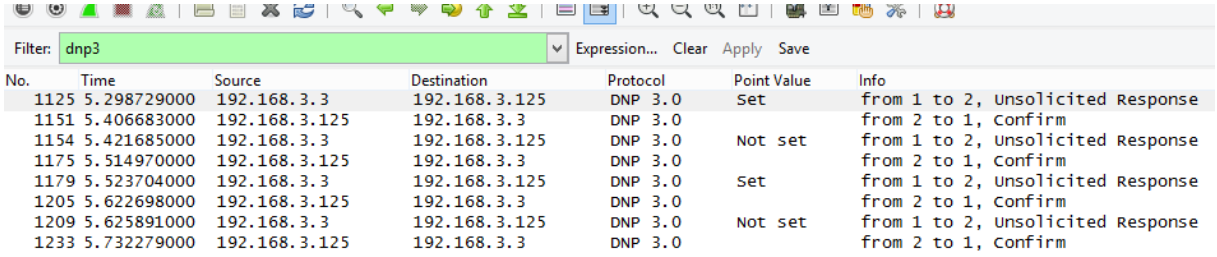


Figure 1 - All the four data at the same time (captured with Wireshark)



Filter: dnp3 Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Point Value	Info
1125	5.298729000	192.168.3.3	192.168.3.125	DNP 3.0	Set	from 1 to 2, Unsolicited Response
1151	5.406683000	192.168.3.125	192.168.3.3	DNP 3.0		from 2 to 1, Confirm
1154	5.421685000	192.168.3.3	192.168.3.125	DNP 3.0	Not set	from 1 to 2, Unsolicited Response
1175	5.514970000	192.168.3.125	192.168.3.3	DNP 3.0		from 2 to 1, Confirm
1179	5.523704000	192.168.3.3	192.168.3.125	DNP 3.0	Set	from 1 to 2, Unsolicited Response
1205	5.622698000	192.168.3.125	192.168.3.3	DNP 3.0		from 2 to 1, Confirm
1209	5.625891000	192.168.3.3	192.168.3.125	DNP 3.0	Not set	from 1 to 2, Unsolicited Response
1233	5.732279000	192.168.3.125	192.168.3.3	DNP 3.0		from 2 to 1, Confirm

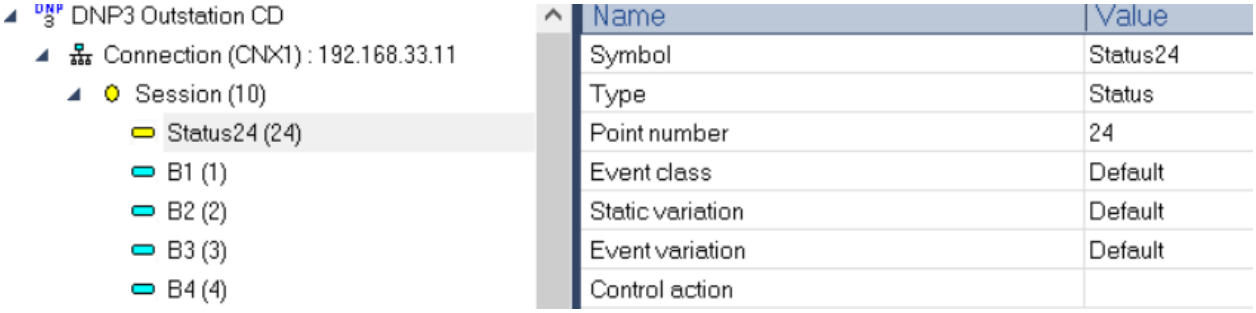
Figure 2 - Four data in four different packets (captured with Wireshark)

Note: The runtime's speed capacity may vary; it partly depends on the system.

7. Status varaibles

Status variables can be added to improve diagnostic

For the point configuration only point number is significant. All others parameters are ignored



Point number 3: Nb Invalid Bytes Received

Point number 6: Nb Frame CRC Errors

Point number 13: Nb Frames Received

Point number 15: Nb Link Status Error

You can detect a connection error if "Link Status Error" has been incremented.

If "Nb Frames Received" is incremented the master sent a valid frame i.e. connection should be good again

Point number 24 – Current state:

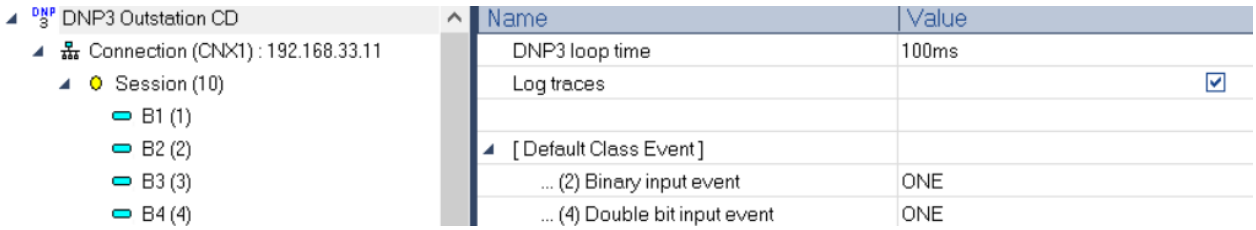
IDLE = 0, ERROR = 1, CONNECTING = 2, CONNECTED = 3

8. DNP3 Loop Time

It is possible to modify the DNP3 Loop Time. This option allows the user to diminish or increase the refreshment delay of the DNP3 stack.

By default this delay is set to 100ms.

This parameter can be found in the Slave settings, by clicking on the Slave node in the Fieldbus Configuration ( ):



Note:

Due to some hardware configurations, there are some restrictions concerning this parameter.

It can't be too small otherwise some errors could occur, for example communication loss.

9. Control action

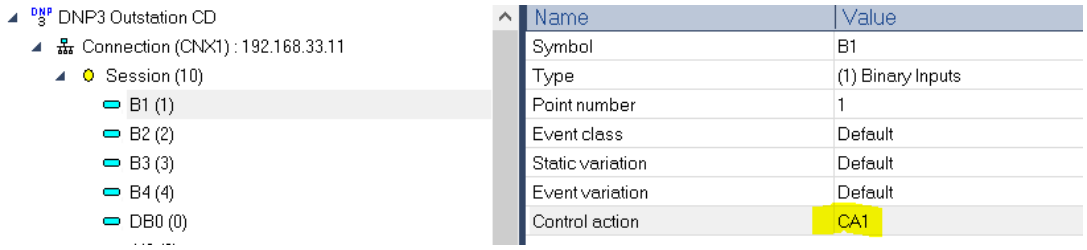
Digital Outputs and Analog Outputs must be written using Select Before Operate (SBO) and Direct Operate sequences.

A native implementation of this mechanism is provided in the target to facilitate the programmer.

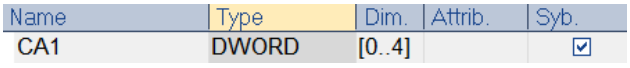
For particular purpose, the programmer can handle the sequences using UDFBs.

Using UDFB to handle control action

To handle control action using UDFB you need first to link a control action variable to the controlled variable



The variable named B1 will be controlled with UDFB using variable named CA1



CA1 must be declared as an array of 5 DWORD and must be embedded

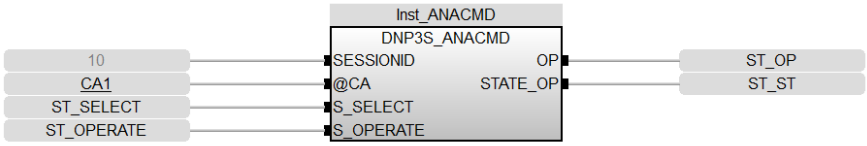
If the field 'control action' is empty the variable B1 can't be controlled by an UDFB. In this case, default rule is used using internal coding.

Handle control action for Analog Value

You must use the UDFB named DNP3S_ANACMD to handle control action for analog variable.

DNP3S_ANACMD is part of straton Workbench library.

For particular purpose, you can write your own UDFB.




```
SESSIONID  : Session number defined in fieldbus configurator
@CA        : Array of 5 DWORD
S_SELECT   : Input value for SELECT operation
S_OPERATE  : Input value for OPERATE operation
OP         : Current operation
STATE_OP   : Current status of operation
```

CA array description (do not update the array from straton workbench manually)

bit	31	30	29	23-16	15	7-0
CA[0]	Command 0/1	Abort 0/1	Init 0/1	Command value _DNP3S_CODE_SELECT _DNP3S_CODE_OPERATE _DNP3S_CODE_DIRECTOPERATE	Response 0/1	Response value _DNP3S_STATUS_SUCCESS ... _DNP3S_STATUS_UNDEFINED ...

SELECT AND OPERATE: NO ERROR

- Initial state

```
S_SELECT          = _DNP3S_STATUS_PENDING
S_OPERATE         = _DNP3S_STATUS_PENDING
STATE_OP          = undefined
OP                = undefined
```

- Master initiate a Select and Operate command

CA[ ] is filled according to CA array description

	Current value	Next value
CA[0].29	0	1

- Start sequence:

CA[0].29	1	0
OP	undefined	0
STATE_OP	undefined	_DNP3S_STATUS_UNDEFINED

- SBO Sequence

S_SELECT	_DNP3S_STATUS_PENDING	
OP	0	_DNP3S_CODE_SELECT
STATE_OP	_DNP3S_STATUS_UNDEFINED	_DNP3S_STATUS_PENDING

… Here you can delay the select

S_SELECT	_DNP3S_STATUS_PENDING	_DNP3S_STATUS_SUCCESS
OP	_DNP3S_CODE_SELECT	_DNP3S_CODE_OPERATE
STATE_OP	_DNP3S_STATUS_UNDEFINED	_DNP3S_STATUS_SUCCESS

S_OPERATE	_DNP3S_STATUS_PENDING	
OP	_DNP3S_CODE_OPERATE	
STATE_OP	_DNP3S_STATUS_SUCCESS	_DNP3S_STATUS_PENDING

… Here you can delay the Operate

S_OPERATE	_DNP3S_STATUS_PENDING	_DNP3S_STATUS_SUCCESS
OP	_DNP3S_CODE_OPERATE	
STATE_OP	_DNP3S_STATUS_PENDING	_DNP3S_STATUS_SUCCESS

- End of sequence

SELECT AND OPERATE: ERROR TIMEOUT

- Initial state

```
S_SELECT   = _DNP3S_STATUS_PENDING
S_OPERATE          = _DNP3S_STATUS_PENDING
STATE_OP   = undefined
OP         = undefined
```

- Master initiate a Select and Operate command

CA[ ] is filled according to CA array description

	Current value	Next value
CA[0].29	0	1

- Start sequence:

CA[0].29	1	0
OP	undefined	0
STATE_OP	undefined	_DNP3S_STATUS_UNDEFINED

- SBO Sequence

S_SELECT	_DNP3S_STATUS_PENDING	
OP	0	_DNP3S_CODE_SELECT
STATE_OP	_DNP3S_STATUS_UNDEFINED	_DNP3S_STATUS_PENDING

… Here you can delay the select

S_SELECT	_DNP3S_STATUS_PENDING	_DNP3S_STATUS_SUCCESS
OP	_DNP3S_CODE_SELECT	_DNP3S_CODE_OPERATE
STATE_OP	_DNP3S_STATUS_UNDEFINED	_DNP3S_STATUS_SUCCESS

S_OPERATE	_DNP3S_STATUS_PENDING	
OP	_DNP3S_CODE_OPERATE	
STATE_OP	_DNP3S_STATUS_SUCCESS	_DNP3S_STATUS_PENDING

S_OPERATE	_DNP3S_STATUS_PENDING	_DNP3S_STATUS_TIMEOUT
OP	_DNP3S_CODE_OPERATE	
STATE_OP	_DNP3S_STATUS_PENDING	_DNP3S_STATUS_TIMEOUT

- End of sequence

SELECT AND OPERATE: ERROR COMMAND ABORT

- Initial state

```
S_SELECT   = _DNP3S_STATUS_PENDING
S_OPERATE          = _DNP3S_STATUS_PENDING
STATE_OP   = undefined
OP         = undefined
```

- Master initiate a Select and Operate command

CA[ ] is filled according to CA array description

	Current value	Next value
CA[0].29	0	1

- Start sequence:

CA[0].29	1	0
OP	undefined	0
STATE_OP	undefined	_DNP3S_STATUS_UNDEFINED

- SBO Sequence

S_SELECT	_DNP3S_STATUS_PENDING	
OP	0	_DNP3S_CODE_SELECT
STATE_OP	_DNP3S_STATUS_UNDEFINED	_DNP3S_STATUS_PENDING

… Here you can delay the select

S_SELECT	_DNP3S_STATUS_PENDING	_DNP3S_STATUS_SUCCESS
OP	_DNP3S_CODE_SELECT	_DNP3S_CODE_OPERATE
STATE_OP	_DNP3S_STATUS_PENDING	_DNP3S_STATUS_CANCELLED

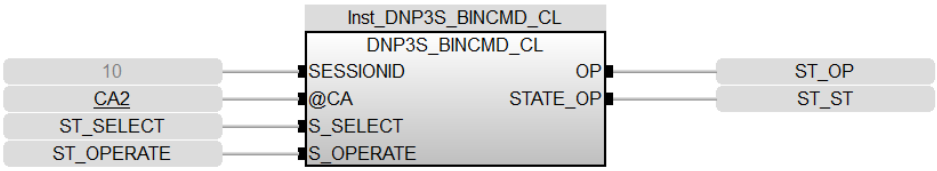
- End of sequence

Handle control action for Binary Value (Complementary Latch Model)

You must use the UDFB named DNP3S_BINCMD_CL to handle control action for binary variable.

DNP3S_BINCMD_CL is part of straton Workbench library.

For particular purpose, you can write your own UDFB.




```
SESSIONID  : Session number defined in fieldbus configurator
@CA        : Array of 5 DWORD
S_SELECT   : Input value for SELECT operation
S_OPERATE  : Input value for OPERATE operation
OP         : Current operation
STATE_OP   : Current status of operation
```

CA array description (do not update the array from straton workbench manually)

bit	31	30	29	23-16	15	7-0
CA[0]	Command 0/1	Abort 0/1	Init 0/1	Command value _DNP3S_CODE_SELECT _DNP3S_CODE_OPERATE _DNP3S_CODE_DIRECTOPERATE	Response 0/1	Response value _DNP3S_STATUS_SUCCESS ... _DNP3S_STATUS_UNDEFINED ...

bit	31-23	23-16	15-8	7-0
CA[1]	Operation _DNP3S_OP_NUL _DNP3S_OP_PULSEON _DNP3S_OP_PULSEOFF _DNP3S_OP_LATCHON _DNP3S_OP_LATCHOFF	Clear 0/1	TCC _DNP3S_TCC_NUL _DNP3S_TCC_CLOSE _DNP3S_TCC_TRIP	Count (not used)

Bit	31-0
CA[4]	Reserved

SELECT AND OPERATE: NO ERROR

- Initial state

```
S_SELECT   = _DNP3S_STATUS_PENDING
S_OPERATE          = _DNP3S_STATUS_PENDING
STATE_OP   = undefined
OP         = undefined
```

- Master initiate a Select and Operate command

CA[ ] is filled according to CA array description

	Current value	Next value
CA[0].29	0	1

- Start sequence:

CA[0].29	1	0
OP	undefined	0
STATE_OP	undefined	_DNP3S_STATUS_UNDEFINED

- SBO Sequence

S_SELECT	_DNP3S_STATUS_PENDING	
OP	0	_DNP3S_CODE_SELECT
STATE_OP	_DNP3S_STATUS_UNDEFINED	_DNP3S_STATUS_PENDING

… Here you can delay the select

S_SELECT	_DNP3S_STATUS_PENDING	_DNP3S_STATUS_SUCCESS
OP	_DNP3S_CODE_SELECT	_DNP3S_CODE_OPERATE
STATE_OP	_DNP3S_STATUS_UNDEFINED	_DNP3S_STATUS_SUCCESS

S_OPERATE	_DNP3S_STATUS_PENDING	
OP	_DNP3S_CODE_OPERATE	
STATE_OP	_DNP3S_STATUS_SUCCESS	_DNP3S_STATUS_PENDING

… Here you can delay the Operate

S_OPERATE	_DNP3S_STATUS_PENDING	_DNP3S_STATUS_SUCCESS
OP	_DNP3S_CODE_OPERATE	
STATE_OP	_DNP3S_STATUS_PENDING	_DNP3S_STATUS_SUCCESS

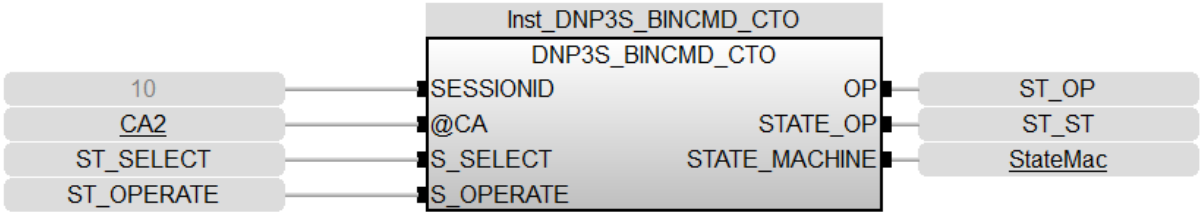
- End of sequence

Handle control action for Binary Value (Complementary Two Output Model)

You must use the UDFB named DNP3S_BINCMD_CTO to handle control action for binary variable.

DNP3S_BINCMD_CTO are part of straton Workbench library.

For particular purpose, you can write your own UDFB.




```
SESSIONID         : Session number defined in fieldbus configurator
@CA               : Array of 5 DWORD
S_SELECT          : Input value for SELECT operation
S_OPERATE         : Input value for OPERATE operation
OP                : Current operation
STATE_OP          : Current status of operation
STATE_MACHINE     : Current state of internal latch/pulse
```

CA array description (do not update the array from straton workbench manually)

bit	31	30	29	23-16	15	7-0
CA[0]	Command 0/1	Abort 0/1	Init 0/1	Command value _DNP3S_CODE_SELECT _DNP3S_CODE_OPERATE _DNP3S_CODE_DIRECTOPERATE	Response 0/1	Response value _DNP3S_STATUS_SUCCESS ... _DNP3S_STATUS_UNDEFINED

bit	31-23	23-16	15-8	7-0
CA[1]	Operation _DNP3S_OP_NUL _DNP3S_OP_PULSEON _DNP3S_OP_PULSEOFF _DNP3S_OP_LATCHON _DNP3S_OP_LATCHOFF	Clear 0/1	TCC _DNP3S_TCC_NUL _DNP3S_TCC_CLOSE _DNP3S_TCC_TRIP	Count (not used)

bit	31-0
CA[2]	OnTime
bit	31-0
CA[3]	OffTime
Bit	31-0
CA[4]	Reserved

SELECT AND OPERATE: NO ERROR

- Initial state

```
S_SELECT          = _DNP3S_STATUS_PENDING
S_OPERATE                 = _DNP3S_STATUS_PENDING
STATE_OP          = undefined
OP                = undefined
STATE_MACHINE     = undefined
```

- Master initiate a Select and Operate command

CA[] is filled according to CA array description

	Current value	Next value
CA[0].29	0	1

- Start sequence:

CA[0].29	1	0
OP	undefined	0
STATE_OP	undefined	_DNP3S_STATUS_UNDEFINED
STATE_MACHINE	undefined	_DNP3S_SM_NUL

- SBO Sequence

S_SELECT	_DNP3S_STATUS_PENDING	
OP	0	_DNP3S_CODE_SELECT
STATE_OP	_DNP3S_STATUS_UNDEFINED	_DNP3S_STATUS_PENDING
STATE_MACHINE	_DNP3S_SM_NUL	

... Here you can delay the select

S_SELECT	_DNP3S_STATUS_PENDING	_DNP3S_STATUS_SUCCESS
OP	_DNP3S_CODE_SELECT	_DNP3S_CODE_OPERATE
STATE_OP	_DNP3S_STATUS_UNDEFINED	_DNP3S_STATUS_SUCCESS
STATE_MACHINE	_DNP3S_SM_NUL	

S_OPERATE	_DNP3S_STATUS_PENDING	
OP	_DNP3S_CODE_OPERATE	
STATE_OP	_DNP3S_STATUS_SUCCESS	_DNP3S_STATUS_PENDING
STATE_MACHINE	_DNP3S_SM_NUL	

... Here you can delay the Operate

S_OPERATE	_DNP3S_STATUS_PENDING	_DNP3S_STATUS_SUCCESS
OP	_DNP3S_CODE_OPERATE	
STATE_OP	_DNP3S_STATUS_PENDING	_DNP3S_STATUS_SUCCESS
STATE_MACHINE	_DNP3S_SM_INPROGRESS	

.... Wait during OnTime/OffTime

S_OPERATE	_DNP3S_STATUS_SUCCESS	
OP	_DNP3S_CODE_OPERATE	
STATE_OP	_DNP3S_STATUS_SUCCESS	
STATE_MACHINE	_DNP3S_SM_INPROGRESS	_DNP3S_SM_FINISHED

- End of sequence

10. ANNEX 1

Values used to manage control action

Command status (used with binary output and analog output)

_DNP3S_STATUS_SUCCESS	0
_DNP3S_STATUS_TIMEOUT	1
_DNP3S_STATUS_NOSELECT	2
_DNP3S_STATUS_FORMATERROR	3
_DNP3S_STATUS_NOTSUPPORTED	4
_DNP3S_STATUS_ALREADYACTIVE	5
_DNP3S_STATUS_HARDWAREERROR	6
_DNP3S_STATUS_LOCAL	7
_DNP3S_STATUS_TOOMANYOBJECTS	8
_DNP3S_STATUS_NOTAUTHORIZED	9
_DNP3S_STATUS_AUTOMATIONINHIBIT	10
_DNP3S_STATUS_PROCESSINGLIMITED	11
_DNP3S_STATUS_OUTOFRANGE	12
_DNP3S_STATUS_DOWNSTREAMLOCAL	13
_DNP3S_STATUS_ALREADYCOMPLETE	14
_DNP3S_STATUS_BLOCKED	15
_DNP3S_STATUS_CANCELLED	16
_DNP3S_STATUS_BLOCKEDOTHERMASTER	17
_DNP3S_STATUS_DOWNSTREAMFAIL	18
_DNP3S_STATUS_UNDEFINED	127
_DNP3S_STATUS_PENDING	255

Command (used with binary output and analog output)

_DNP3S_CODE_SELECT	16#01
_DNP3S_CODE_OPERATE	16#02
_DNP3S_CODE_DIRECTOPERATE	16#04

Operation type (used with binary output command)

_DNP3S_OP_NUL	0
_DNP3S_OP_PULSEON	1
_DNP3S_OP_PULSEOFF	2
_DNP3S_OP_LATCHON	3
_DNP3S_OP_LATCHOFF	4

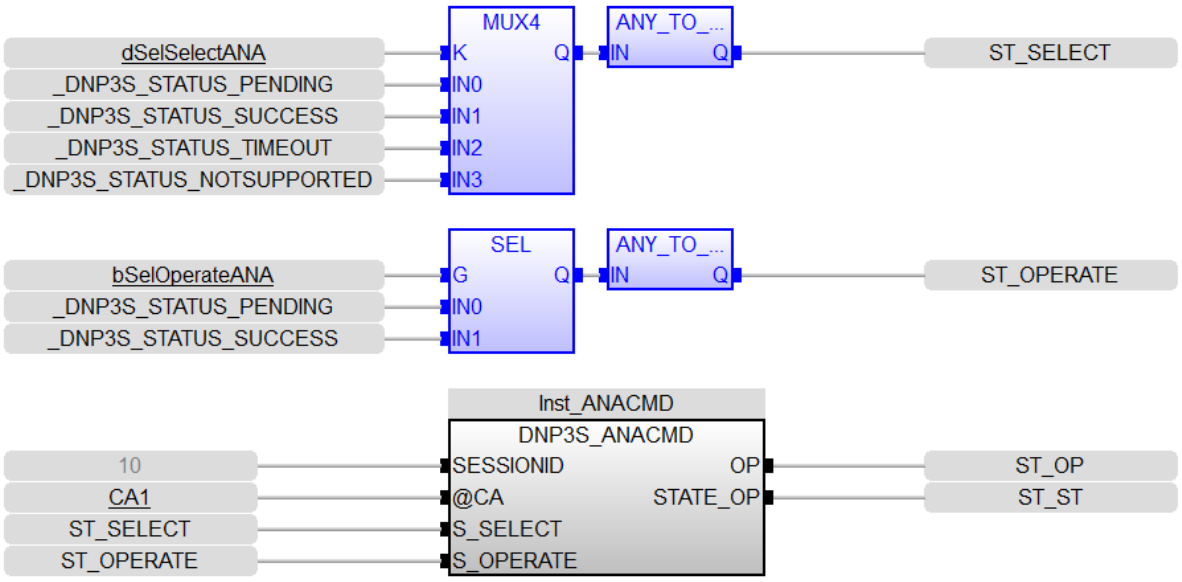
Trip-Close Code field (used with binary output command)

_DNP3S_TCC_NUL	0
_DNP3S_TCC_CLOSE	1
_DNP3S_TCC_TRIP	2

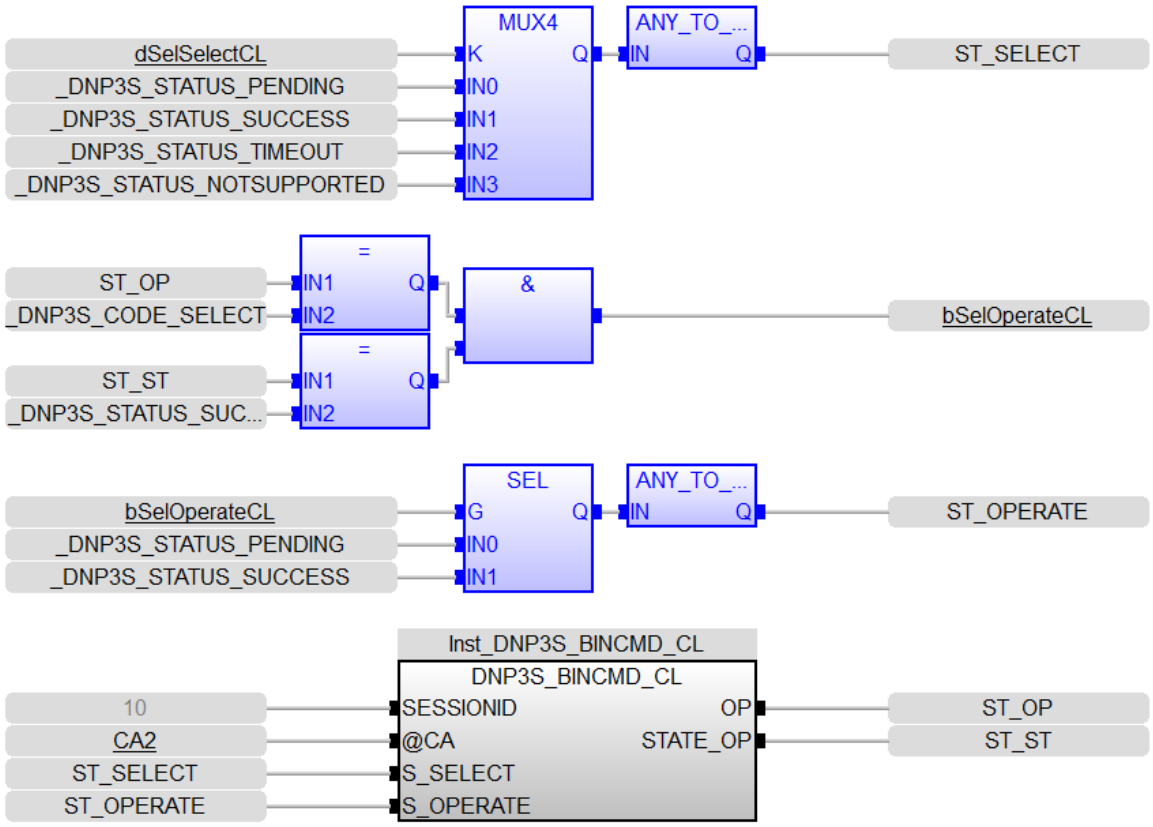
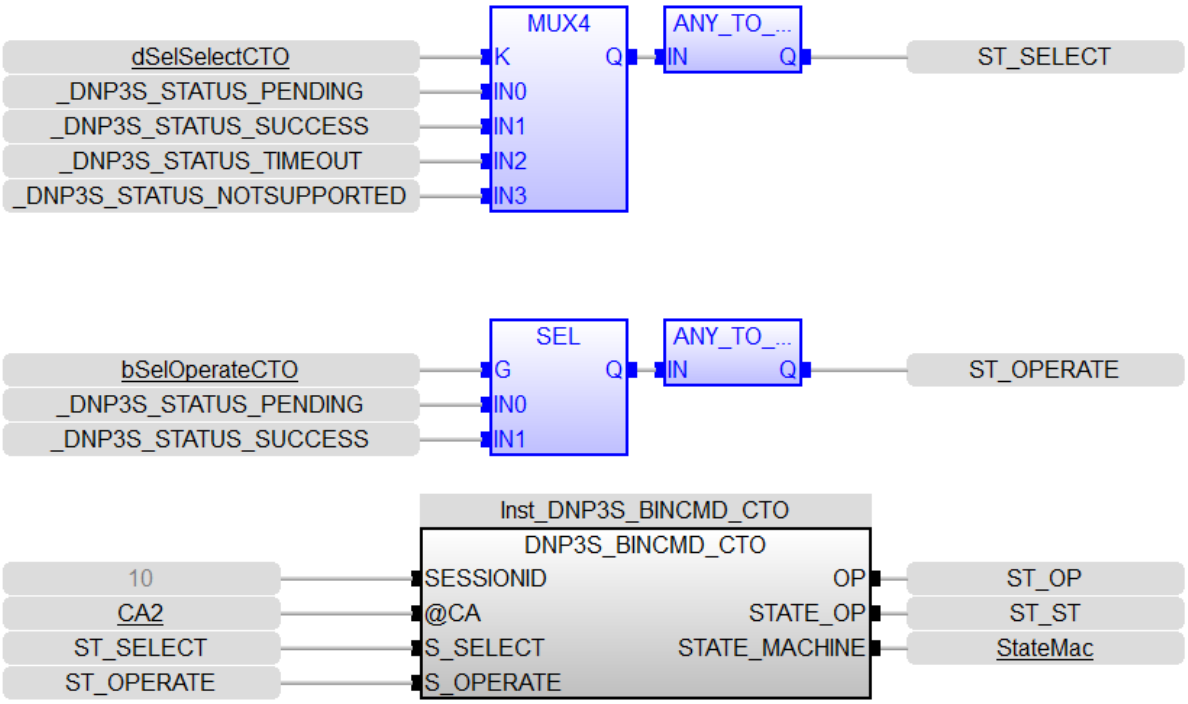
State machine (used with binary output command)

_DNP3S_SM_NUL	0
_DNP3S_SM_INPROGRESS	1
_DNP3S_SM_FINISHED	2

FBD short example : DNP3S_ANACMD



FBD short example : DNP3S_BINCMD_CL



FBD short example : DNP3S_BINCMD_CTO